THE GENUS *POA* LINN. IN INDIA

BY

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PART I

(With three plates and thirteen text figures)

SUMMARY

In the Flora of British India the species of *Poa* were worked up by the late Dr. Otto Stapf and in all 17 species were described. Of these, the species called *Poa persica* Trin. has been made the type of a new genus, *Eremopoa* Roshev., by the Russian botanist Roshevitz. The characteristics of *Eremopoa* Roshev. are so different from those of *Poa* Linn., particularly in the nervation of the lemma, that there is no doubt that they are better kept apart. This leaves sixteen species of *Poa* for India.

In the present study, forty-nine species are described, and it is by no means certain that this number covers all the valid species of the Himalaya and neighbouring areas. Some of these forty-nine species have not so far been found within the political boundaries of India and Pakistan, but as they occur just over the border, it may be assumed that they will sooner or later be found within the geographical area known as India, since there are no natural barriers to their spread.

Introduction

The name *Poa*, from the Greek πόα, πόη, ποίη, grass, herb or fodder, apparently was not used to designate any particular plant until Linnaeus founded the genus *Poa* in his *Genera Plantarum* 20 (1737)*, a genus which appeared in each successive edition of the book with the characteristics unchanged. In the first edition of his *Species Plantarum* 67 (1753), Linnaeus gave binomials to 17 species in this genus, the majority of which still remain in the genus *Poa* as conceived by modern agrostologists. The remainder have been transferred to other genera, e.g. *Eragrostis*, as necessity arose.

The systematic treatment of the species of the genus *Poa* is one of the most bewildering and difficult of taxonomic studies. While many species are clear cut and can be recognised at a glance, there are groups of species about which one can only conclude that their evolu-

* In the first four editions of this work, Linnaeus refers to the *Agrostographia* of Scheuchzer, published in 1719, for illustrations of the genus *Poa*. By a curious error, which remained undetected through four editions of the *Genera Plantarum*, Linnaeus quotes tabula IV, fig. 17, instead of tabula, III, fig. 17. In the sixth edition of the *Genera Plantarum*, published in 1754, Linnaeus drops all reference to Scheuchzer, since, as he tells us in the preface to the edition, 'citationes auctorum pro determinandis speciebus expunximus', since these are to be found in *Species Plantarum*, 1753.

tionary history has been so complex that they do not lend themselves to systematic treatment by present taxonomic methods. One cannot rely upon a single character to separate species in such groups, but combinations of more or less variable characters must be used—a procedure, it must be confessed, which often leads to the recognition of species by what is suspiciously like guesswork, even if it is termed experience or intuition.

The foregoing statements do not apply to the Indian species of *Poa* only, but have been the experience of all workers in this field, no matter what flora has been the subject of their studies. One of the reasons for these difficulties is presumably hybridization and polyploidy followed by apomixis. This suggests that the only satisfactory way of dealing with such difficult groups will be by experimental analysis.

So far no experiments of this kind have been undertaken with any of the Indian species and it seems as if these experiments are far distant. This, however, should not be a valid reason for postponing a revision of the genus in India, for, no matter how difficult and complex the study is or how desirable a knowledge of the genetic basis for each species may be, there are still collections to be named.

Until all the data necessary to give the complete picture have been obtained, the taxonomist must do the best he can with the material at hand. At any rate we are very far from the stage in our knowledge of the genus *Poa* about which Stebbins (1950) surmises ' when this genus is better known, it may have to be regarded as a single huge polyploid complex, which is in part purely sexual, in part facultatively apomictic, and which contains in addition obligate apomicts '.

Difficulties of classification in default of breeding experiments and analysis have so far been tackled in adjacent areas (India and Russia) in two ways, neither of which is entirely satisfactory. The first method is to widen the characters of certain species to such an extent that these species become a kind of dustbin to which many of the aberrant or doubtful specimens can be relegated.

In this method the concept of a species of *Poa* may include characters which are as divergent as firm and herbaceous lemmas, wool or no wool, keels of the palea which are scabrid or ciliate, anthers large or small, ligules long or short, and so forth.

Such a hypothetical species becomes a polymorphic assemblage with extremes looking as different from one another as only two distinct species can. For typical examples of this method, one had only to look at the treatment of the two species *Poa nemoralis* Linn. and *P. annua* Linn. in the *Flora of British India*. Now, if the ambit of *P. nemoralis* Linn. is extended to include specimens with a long ligule and lower glumes which may be lanceolate, oblong-elliptic or even ovate in shape, it is quite clear that *P. nemoralis* as understood by Linnaeus will be swamped in the flood of specimens which obviously look different but which, thanks to the widening of the characters, fall pat into the artificial and capacious receptacle created for them.

In the folders of Indian *P. nemoralis* at Kew, Edinburgh, Calcutta and Dehra Dun were to be found a small number of sheets only which could actually be identified as true *P. nemoralis* Linn. The erection of var. *ligulata* Stapf permitted numerous sheets of *P. sterilis* M.B., *araratica* Trautv. and several other species to be included.

The treatment of *Poa annua* Linn. in the same work is just as

unsatisfactory. This cosmopolitan species is usually a lax annual, sometimes biennial, but very rarely perennial—there is little or no wool at the base of the lemmas—the lemmas are herbaceous, green, with cilia on the keel and outer nerves—the paleae are ciliate on the keels—the anthers are almost 0·8 mm. long. The erection of two varieties, var. *nepalensis* and var. *sikkimensis* in the *Flora of British India*, widens these characters so that the *Poa annua* of India is annual or perennial, with wool or without wool, with keels of the palea ciliate or ciliate below and scabrid above, with lemmas very firm or herbaceous, with all nerves ciliate or only the outer, with anthers varying in length from 0·4 mm. to 2 mm. Into the hypothetical species possessing these characters it is possible to fit *P. annua* Linn., *P. supina* Schrad., *P. infirma* H.B.K., *P. nepalensis* Wall. and *P. sikkimensis* Bor, all of which differ in morphology, habit and appearance, and some even have different chromosome numbers.

The second method is to take a single character as a basis and to divide the species of the genus into two parts on the criterion of its presence or absence. The most frequently used character for this initial subdivision is the nervation of the lemmas. In one group the nerve between the lateral and keel nerves is extremely prominent, while in the other group it is very faint. Each of the two divisions so obtained could again be subdivided by taking another character, say, wool or no wool at the base of the lemma. Further subdivisions would demand other contrasting characters. In this way a rigid dichotomous key is obtained and this is the method, one feels, that has been followed in the *Flora U.S.S.R.* Vol. 2. for in the treatment of the genus *Poa* in that book, which incidentally runs to 106 species, the species are separated in the key on just such characters as the above. If the dichotomy in the key is based upon contrasting characters which are not absolutely reliable, then the whole system breaks down and makes the determination of species by means of a key impossible. In the absence of data obtained by experimental techniques the writer of this paper feels that an intermediate position between the two extremes is in the circumstances the best course to pursue. By this means the unreasonable expansion of the limits of the species, and hence the inevitable lumping, on the one hand, is avoided, and, on the other, that while due regard is given to the status of recognisable species, excessive splitting on doubtful characters is likewise excluded.

The procedure however does not solve the question of the treatment of the more difficult groups, and the writer has come to the conclusion that it is quite impossible to deal with the members of such groups by the ordinary classical methods, but that species must be lumped to be dealt with later when, by breeding experiments, the exact relationship of the members of the group can be elucidated.

Taxonomic Characters and their Reliability

Before any key to a genus can be drawn up a decision has to be made regarding the characters to be used for the separation of species. And after the selection of such characters has been made, further consideration must be given to the confidence or weight which can be placed in these characters.

Such decisions can only be made after experience has been gained by the examination and dissection of a large mass of material. To this end the collections of the genus in the great herbaria of England, India, Paris and Holland have been examined, particularly those of the Royal Botanic Gardens, Kew ; the British Museum (South Kensington) ; the Royal Botanic Gardens, Edinburgh ; the National Botanic Gardens, Calcutta ; the Forest Research Institute, Dehra Dun; and the Rijks-herbarium, Leiden. After examination of this very large mass of material, one is forced to the conclusion that, in so far as the genus *Poa* in India is concerned, there is no single character which can be selected (except possibly one) in which absolute reliance can be placed. The degree of reliability also varies. Some characters are almost always present, others fairly constant, while others only occasionally can be found. The one exception to which reference has been made is the possession of scaly rhizomes. I have yet to find a specimen of *Poa pratensis* which does not possess this organ. But here again it is often missing in herbarium specimens, though usually the remains of it can be made out.

The compilation of a key to the species of *Poa* is therefore a matter of considerable labour, and the writer has been reduced to a state of extreme exasperation on more than one occasion by the discovery that the carefully-built edifice has had to be destroyed because one specimen of a species did not possess the vital character. The fact of the matter is that groups of characters have to be used, and this method, in a dichotomous key, means the repetition of species in the contrasting sections.

In the following pages an attempt is made to list and evaluate characters for diagnostic purposes in the light of experience gained from the examination of the material at hand.

Colour

Although species of *Poa* exhibit many different shades of green, it is difficult to make use of the variations since they are often partly due to habitat conditions. Another difficulty is that of conveying in words the exact description of a shade of green. Still it is possible to make a limited use of colour differences. As, for example, the two grasses, *Poa litwinowiana* Ovcz. and *P. koelzii* Bor, can be picked out at once because of their extremely glaucous aerial parts. As for shades of green, *P. annua* Linn. is light green, *P. compressa* Linn. has a bluish tinge in the green and *P. pratensis* Linn. is said to be dark green in colour.

Some species are much paler and *P. sterilis* M.B. is one such, while its close relative *P. araratica* Trautv. is equally pale but has a reddish or purplish shade in the basal sheaths.

P. tibetica Munro is distinguished by its very pale spikelets, while the spikelets of many of the other species which grow at high altitudes are suffused with purple. But this purple colour, although it usually can be correlated with high altitudes, is too variable to be of any value as a diagnostic character. Other species, again, have bands of gold or orange near the tip of the spikelet and this is sometimes of limited value in diagnosis.

Vegetative Characters

Roots

The dense fibrous shallow roots of the species of *Poa* vary so much in appearance and size in response to habitat conditions that no reliance can be placed upon them for diagnostic purposes.

Shoots

In addition to the vertical vegetative shoots which usually end in the inflorescence, the genus *Poa* has two types of horizontal modified shoots : underground shoots or rhizomes and stolons which creep over the surface.

Culms

In most species the culms are terete and smooth but some are scabrid below the panicle, and this is taken in some floras to be diagnostic. While in some instances the scabridity is of such a degree as to be noticeable to the touch, it is usually much less apparent. Seen under a lens, however, it is safe to say that a large proportion of species are at least minutely scabrid below the inflorescence, where the scabridity takes the form of very minute, well-spaced teeth on the nerves.

In one species only, *P. compressa* Linn., is the culm markedly compressed. This is of diagnostic importance in the field, but in a pressed herbarium specimen the character is lost or masked.

Stolons

P. trivialis Linn. is strongly stoloniferous, the prostrate stems creeping widely, rooting at the nodes and sending up flowering shoots. *P. nemoralis* Linn. is a species that is weakly stoloniferous.

Rhizomes

The possession of these organs is a most reliable feature and is quite characteristic of the group into which *P. pratensis* falls.

Poa alpigena has a characteristically curved underground stem which is very constant and distinguishes at once living and herbarium specimens from other species.

Poa araratica possesses a striking rootstock, really a thick rhizome with very short nodes, but it is rarely present on herbarium sheets as, when carelessly collected, the culms of this species break off easily at the base, and the rootstock is left in the ground. The culms grow closely crowded together arising from the short, stout, inclined or almost horizontal rootstock which is quite characteristic and which, if present, separate this species at once from the closely related *Poa sterilis* M.B. with which it is often confused. The latter does not arise from a rhizome of this kind, and the circumstance emphasises once again the necessity for careful collecting if correct identifications are to be made.

The two species *P. himalayana* Nees and *P. stewartiana* Bor are very close together: the former possesses a rhizome while the latter does not. They are easily separated on this feature alone.

Appendages to the Vegetative Shoots

Sheaths

The firmly compressed sheaths of *Poa compressa* Linn. are characteristic, but then the sheaths are more or less compressed in most species, and when dried specimens are being examined no reliance can be placed on this character.

The scabrous sheaths of *Poa trivialis* Linn. are often considered to be diagnostic, but the character breaks down in the form of this species which has smooth sheaths! Indeed, in many species the sheaths are more or less scabrid and the roughness is very variable in amount, even in the same species.

In the series *Bulbosae* the swollen leaf bases, which give the base of these plants a bulbous appearance, are quite distinctive. The grasses which form this group can be separated with confidence from other *Poae* by the possession of this character alone. The bases of the sheaths of non-flowering shoots of these species become thickened and succulent, and act as storage organs where starch and reserve cellulose can be accumulated.

In *Poa alpina* Linn. the basal sheaths decay very tardily, so that the base, consisting mainly of dead and partly disintegrated sheaths, becomes thicker and thicker. Loose, scarious, smooth sheaths are characteristic of *P. pagophila* Bor, *P. hirtiglumis* Stapf and *P. polycolea* Stapf.

The basal sheaths of *P. araratica* Trautv. are distinctly reddish-purple in colour, though this does not hold good for every specimen. The colour is absent in the specimens of the closely related *P. sterilis* M.B.

Ligules

The length of the ligule is an important and often diagnostic feature, and there appears to be little variation in ligule-length within a single species.

The range within the Indian species is considerable, varying as it does from practically none to 7 mm. long.

At one end of the scale are *P. nemoralis* Linn. and *P. khasiana* Stapf. In the former the ligule is very short, often practically absent and never more than 0·5 mm. long. In the latter it is longer, but still not more than 1 mm. long. At the other end of the scale are *P. pagophila* Bor, *P. lahulensis* Bor, and *P. jaunsarensis* Bor—which have ligules over 5 mm. long.

Most ligules are truncate or rounded on the upper margin and become lacerate with age. The ligule of *P. trivialis* Linn., however, ends in a more or less sharp point, a feature which is diagnostic, provided other essential characters are present.

The texture of the ligule varies from hyaline to membranous or chartaceous, and it is sometimes milky or brownish in colour. The

outer surface of the ligule is sometimes scabrid, but this scabridity is so variable as to be worthless as a distinguishing character. In the descriptions of the species the ligule-lengths recorded are those of the ligule of the topmost leaf.

Leaves

The leaves in the genus are mostly linear in shape, tapering abruptly to a point which is hooded like the prow of a boat. But this characteristic is not uniform throughout the genus, for the leaves of *P. trivialis* Linn., *P. gammieana* Stapf and *P. palustris* Linn. end in a long acuminate tip which is quite different from that just mentioned. The texture of the leaves may be firm or flaccid, they may be green or even pale green, or glaucous or variously suffused with purple. The leaves of all species are folded in the bud.

It is a moot point whether the size and texture of the leaves can in general be taken as reliable characters in the separation of species since these depend so much upon habitat.

In one instance, however, two species very much alike in other respects, can be separated with certainty on the width of the leaves. These two species are *Poa pratensis* and *Poa angustifolia* in which the leaves are much smaller and narrower in the latter than in the former—a circumstance which makes the two grasses look very different in the field or in a herbarium specimen.

The margins of leaves and their surfaces are usually smooth, though asperities can be made out with a lens. Feinbrunn[6] makes use of this scabridity as an additional character by which *Poa sinaica* Boiss. can be separated from *Poa eigii* Feinbrunn, the latter being scaberulous on the margins of the leaves only, while the former is scaberulous on the surface and on the margins. Whether this difference is a constant feature in all leaves of the two species, or in any way reliable, is open to question. In *Poa asperifolia* Bor, however, the leaves are so scabrid to the touch that the scabridity alone is almost sufficient to determine the species.

Leafiness, or the reverse, is so difficult to define precisely that no matter what conception the worker on *Poa* has in his own mind, it is perhaps better not to try and use it as a contrasting character. Yet, looking through a series of folders, one does get the idea that, compared with others, some *Poae* are distinctly leafy. For example, long lax leaves are found in *Poa trivialis* Linn., *P. nephelophila* Bor, *P. khasiana* Stapf, *P. nemoralis* Linn., *P. nepalensis* Wall., *P. tibeticola* Bor, and *P. aitchisonii* Boiss. Other species, *Poa sterilis* M.B. and *P. araratica* Trautv., for example, are decidedly less leafy.

The arrangement of leaves is a somewhat better criterion. Numerous flat basal leaves with very short culm leaves are characteristic of *Poa alpina* Linn. and *Poa aitchisonii* Boiss. The leaves of the former often turn purple when dried. The mature basal leaves are folded in *Poa tibetica* Munro and flat in *P. alpina* Linn.

The leaves of the sterile shoots at the base of tufts of *Poa bulbosa* Linn., *Poa sinaica* Steud. and *P. bactriana* Roshev. are very flexuous and threadlike, giving a very distinctive facies to the tuft.

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[6] Kew Bulletin, 1940, 277 (1940).

The leaves of *P. infirma* H.B.K. are extremely thin, almost translucent and far thinner than those of any other Indian species.

Inflorescence

Panicle

The shape of the panicle and its density are important for classification. Most densely spiculate panicles do expand a little as they grow older, but even so they retain their character and are not likely to be mistaken for the effuse wide-spreading panicles common in the meadow grasses.

The length of the pedicel and the branches are important in this respect, as even an expanded spicate inflorescence will retain its densely arranged spikelets.

The number of basal branches is important, and is usually fairly constant. If a species which normally has five basal branches appears to have two or three only it is well to examine the node carefully. Traces will nearly always be found of the missing branches which can be made out as aborted or fused remnants.

The Spikelet

The spikelet consists of glumes, lemmas, paleas, rhachilla, androeceum, gynaeceum and lodicules—each of which will be considered in turn.

First of all, the shape of the spikelet may be characteristic. *P. alpina* Linn., in which the glumes and lemmas are curved on the back, has broadly ovate spikelets, and can be recognised by the spikelet alone. On the other hand, there are numerous species in which the keels of glumes and lemmas are more or less straight, and these have spikelets which are cuneate or oblong-cuneate in shape. In between these two extremes there is a gradual transition from one to the other.

(1) The Glumes

The lower glume is usually smaller and narrower than the upper. The upper is invariably 3-nerved, the lower 1- or 3-nerved. The nervation of the lower glume is more or less constant for the species. The size of the lower glume and its relationship to the other parts of the spikelet is sometimes diagnostic. For example the two species *Poa himalayana* Nees and *P. stewartiana* Bor, are very close to one another. If, however, the spikelets of each are examined, it will be seen that the tip of the lower glume reaches beyond the centre of the keel of the lowest lemma in *Poa stewartiana* Bor, while in *Poa himalayana* Nees the tip of the glume does not reach so far up. Knowledge such as this obviates the necessity for dissection, and an examination of the palea.

In some species the tip of the lower glume exceeds the tip of the lowest lemma in the spikelet. This is an important taxonomic character and only a few Indian species possess it.

The glumes are usually narrowly hyaline on the margins, but in *Poa glabriflora* Roshev. they are curiously translucent, and the bases of the lemmas can be seen through them.

The shape of the lower glume is a good character. Those of *Poa*

nemoralis Linn. and of *P. setulosa* Bor are awl-shaped, that of *P. alpina* Linn. ovate when flattened; others are (and this includes the majority of the species) lanceolate or elliptic-acute when flattened.

(2) Lemma

The grass flower arises in the axil of a scale-like bract or leaf, the lemma, and is enclosed between it and the bracteole or palea. Thus these two scales are in close contact with the most important part of the plant and therefore intimately concerned with its protection. As might be expected these organs show less variability than any others.

In all species the lemma is more or less keeled. In *Poa palustris* Linn. the lemma is sharply keeled below and not above, so that in the fruit the lemma is flattened on the back.

In *Poa calliopsis* Litw. the lemma is more rounded than keeled and is reminiscent of the lemmas in the genus *Colpodium*.

(a) *Colour*

Colour is hardly a reliable factor, but glaucous spikelets are found in *Poa litwinowiana* Ovez. and *P. koelzii* Bor. For the remainder, which possess spikelets of various shades of green, an infusion of purple in the lemma seems to be correlated with habitats at high altitudes. Possibly the colouring matter is a protection against the penetrating rays of the sun in the rarified air of the highest mountain tops. In some of the species which live at high altitudes the purple lemma is divided from the hyaline margin at the tip by a band of golden coloured tissue which makes the spikelet an object of great beauty. A faint yellow band is often present between the hyaline tip of the lemma and the lower green or violet portion.

This can easily be seen in *P. sterilis* M.B., *Poa nemoralis* Linn., *Poa pratensis* Linn. and others. In *P. palustris* Linn. the colour of the band is coppery or orange, but is not always so distinct as to be diagnostic.

(b) *Nervation*

All the lemmas of species of *Poa* have five nerves, the centre one being the keel nerve, about which the lemma itself is folded or compressed.

The texture of the lemma varies within wide limits, though it is constant for a species. Most lemmas tend to become indurated or at least firmer as the seed ripens, and this fact is a point to remember when making use of a character which has been used for a very long time to divide the species into two categories. The section *Pachyneurae* Aschers. contains those species of *Poa* in which the nerve between the keel and marginal nerves on each side is prominent and conspicuous. The other section is the *Leptoneurae* Döll, in which the corresponding nerves are faint and inconspicuous. This subdivision is reasonably satisfactory as long as the lemmas are young. When older, however, the conspicuous intermediate nerve of species in section *Pachyneurae* tends to become inconspicuous as the lemma becomes firmer, so that the significance or reliability of this character becomes masked. Nevertheless this is a very useful subdivision and one which is made use of in many floras.

Personally, I think it can be best applied as an additional—not as a primary—distinguishing character.

(c) *Surface*

The surface of the lemmas in most species of *Poa* is dull and mat, and while they may not be actually scabrid, they are granular in appearance under a lens. The surface actually looks as if it were pitted and glandular. Under a higher power it becomes clear that the granular appearance is due to the numerous silica cells in the epidermis of the lemmas. These are much more numerous in some species than in others. For example, in *P. pratensis* Linn., *P. angustifolia* Linn., *P. wardiana* Bor and others, these silica cells are very numerous, and give a dull appearance to the lemmas which are markedly different in appearance and texture from the shining lemmas of *P. alpina* Linn., *P. lahulensis* Bor and *P. tibetica* Munro in which the silica cells are not so numerous.

Some species are distinctly scabrid on the dorsal surface, not only on the upper parts of the nerves and keel, but on the actual surface between the nerves. *P. wardiana* Bor, *P. gamblei* Bor, and *P. pagophila* Bor may be mentioned as examples of this.

The covering of matted hairs, white or yellowish, which is to be found on the lower half of the lemmas of some species is very remarkable. This feature is a good diagnostic one, but it must be looked for carefully since the short matted hairs are caducous, and in mature spikelets very often all but the barest traces are lost. In *P. hirtiglumis* Stapf, one of this group, the hairs are golden yellow in colour and comparatively long, and are appressed to the surface of the lemma. All the species which possess this feature are high altitude plants, and it is possible that the felty covering serves a useful purpose as an insulating device to protect the androeceum, gynoecium and seed against violent fluctuations of heat and moisture.

Other appendages which are found on the lemma are—(*a*) the ciliate hairs on the nerves, and (*b*) the wool on the callus at the base. First of all it should be stated that there are some species which are almost completely devoid of cilia, hair or wool. Such species are *Poa glabriflora* Roshev., *P. bactriana* Roshev. and *P. poophagorum* Bor, and some races of *P. bulbosa* Linn. and *P. aitchisonii* Boiss. are equally bare.

For the rest every combination can be seen—all the nerves, or only the keel and outer pair, or the keel alone may be ciliate. The presence or absence of the cilia on the nerves are good characters and do not vary much within a species.

The keel is rarely ciliate for more than half its length, the upper half being most often scabrid. The nerves are usually scabrid, not ciliate, in the upper third or quarter.

The wool at the base of the lemma, actually on the callus, is a very good and reasonably reliable character, but not quite good enough to separate a whole genus into two sections. How far this is a genetic character is of course not known, but in the *sterilis* group, for example, the quantity of wool does not appear to be constant. In *P. sterilis* M.B. itself, wool is not considered to be present, but in certain specimens which can undoubtedly be placed under *P. sterilis* M.B. there is wool present, albeit only a strand or two. In the dichotomous key, therefore,

P. sterilis M.B. will be found in both halves. Actually to separate species on the possession or absence of wool, as in the *Flora of the U.S.S.R.*, seems to be a dangerous procedure.

The wool on the callus and the cilia on the nerves appear to consist solely of 1-celled hairs.

(3) Palea

This organ is one of the most important in the grass flower. Morphologically it is the bracteole which is situated between the flower and the rhachilla and is homologous with the prophyllum. Typically the palea is 2-nerved, the nerves being separated by a thin sheet of hyaline tissue which is concave on the adaxial surface. Outside the two nerves are two flaps, both being thin and hyaline. This structure suggests very strongly that its shape and nervation are due to space conditions within the developing spikelet. At any rate the two flaps are pressed against the margins of the lemma and the surface between the nerves against the rhachilla, so that the palea is strongly 2-keeled. The rôle of the palea seems to be a protective one. The hyaline tissue between the keels is sometimes granular from the presence of silica cells, and 1-celled hairs may or may not be present in addition on the adaxial surface. These surfaces may also be very scabrid as in the species *P. wardiana* Bor.

By far the most interesting and important, however, are the appendages to the keels. The keels are invariably armed with either forwardly directed teeth or hooks or spreading 1-celled hairs, the upper half bearing teeth and the lower half cilia.

In the species *Poa calliopsis* these teeth are reduced to a few blunt projections on each keel, but the teeth are numerous and in one or more rows in all the other species except those in which the keels are completely ciliate. For this one species the reduced number of teeth constitutes a diagnostic feature.

Von Oettingen has attempted to use the armature of the palea keels as an additional tool in the identification of species.

After the examination of a large number of specimens he formulated a scheme the salient features of which are as follows:—

He distinguished four groups.

(1) *Pilosae* in which the keels are ciliate from base to apex with longish hairs.

(2) *Semi-pilosae* in which the lower half of the keel is ciliate with the cilia passing insensibly to the teeth above.

(3) *Dentatae* in which there are no hairs but more than one row of hooked teeth.

(4) *Pectinatae* in which the teeth are reduced to a single row on the keel.

In the writer's opinion the possession of hairs, teeth or a mixture of both is of such importance in the identification of species of *Poa* that it is worth while taking some trouble to find out exactly how these structures are arranged.

The palea to be examined should be placed in a drop of water and the keels carefully examined. In young paleas the hairs, if present, are not immediately apparent, and indeed it may be necessary to tease them out. In older paleas the hairs are motile and stand out at once.

These hairs or trichomes are reduced in number or almost entirely aborted in some races of those species in which they are normally present. This sometimes happens in *Poa annua*, one of the commonest of species. It has been found, however, that the hairs are not altogether absent though they may be reduced in extreme instances, to a single trichome. In specimens which exhibit a palea with few or no trichomes on the keels, it is reasonable to search for the species among those listed under *Pilosae* below. In specimens in which the upper part of the keel of the palea is covered with hooks and the lower half bare or almost bare, the species should be sought for under *Semipilosae*. In both these categories there are additional subsidiary characters, which help to separate the species easily.

Apart from such aberrations, experience has shown that the armature of the keels of the palea, when hairs are present, is a very great help towards identification, but that von Oettingen's other two sections are of limited value only.

The writer's opinion is that to attempt to divide all the species which have scabrid keels into two rigid classes, according as they have one row of teeth (*Pectinatae*) or two or more rows (*Dentatae*) is a matter of some difficulty. For, while it is admitted that some can be relegated to one or other category with ease, there are others which appear to occupy an intermediate position. For example, it is quite evident that *P. angustifolia* Linn. has one row of teeth, and that *P. palustris* Linn. has more than one. But it is not so easy to place *P. compressa* Linn., which appears to have teeth in one or more rows.

The following is a list of those species which belong to the sections *Pilosae* and *Semi-pilosae*.

Pilosae

A bare half dozen species belong to this group. They are *P. annua* Linn., *P. hirtiglumis* Stapf, *P. infirma* H.B.K., *P. nepalensis* Wall., *P. supina* Schrad., *P. nephilophila* Bor.

Semipilosae

To this group belong *P. alpina* Linn., *P. burmanica* Bor, *P. gammieana* Hook. f., *P. stapfiana* Bor, *P. stewartiana* Bor. An interesting, but idle, speculation is that these species are fertile hybrids between species in *Pilosae* and species in *Dentatae-Pectinatae*. If this be so, there is no method of telling in our present state of knowledge what the parents may be.

(4) Rachilla

The rachilla in the genus *Poa* is slender and terete and jointed below each floret. It is always prolonged beyond the upper perfect floret and crowned with a rudimentary lemma and palea. The internodes are attached to the base of the adjacent lemma, and the internode and floret fall together when the rachilla breaks up.

The shape of the spikelet depends very largely upon the lengths of the internodes of the rachilla. The compact lanceolate or ovate types are those in which the joints are very short. On the other hand the oblong, loose types are those in which the florets are well spaced. The rachilla joints (internodes) are much longer in *P. nephelophila*

Bor. and *P. polycolea* Stapf than in any of the remainder of the Indian species.

The rachilla is smooth and glabrous in about half of the Indian species, while in the remainder it is shortly hairy, verrucose, or covered with scabridities. It is not possible to use these features to any extent in the separation of species.

The Flower

In the majority of the Indian species of *Poa* all the florets in a spikelet, excluding the terminal rudimentary floret, are usually hermaphrodite, but in one of the commonest Indian species, *Poa annua* L., the lower florets are hermaphrodite, while the upper one or two are female. This arrangement is quite unusual in the genus.

(a) *Androeceum*

The androeceum consists of three stamens, each of which has a long filament surmounted by an anther with 2 loculi opening by longitudinal slits. The size of the anthers does not vary to any extent within a species, except in one known instance, as will be seen later. In so far as the genus in India is concerned, the smallest anthers, 0·22 mm. long, are found in the species *Poa infirma*, and the largest, 3 mm. long in *Poa falconeri*, *P. ludens*, *P. pagophila* and *P. palustris*.

As had been indicated, the size of the anthers is a reliable character and has been used in the key to separate groups. As might have been expected, however, there is an exception to the otherwise general rule. In *Poa stapfiana* (*P. tremula* Stapf) there is a race in which the only difference from the type is the small anthers. Stapf called the variety var. *microtheca* and it is the sole example of a marked variation in the size of the anthers within a species. The peculiarity has of course been allowed for in the key.

As in the majority of species the anthers are bright yellow, but purple anthers and yellow anthers spotted with purple are not unknown, especially in the high altitude species.

(b) *Gynoeceum*

The gynoeceum consists of a one-celled ovary with two styles and two plumose stigmas. There is a single ovary attached to the wall of the carpel.

(c) *Lodicules*

The lodicules are two in number and are more or less 2-toothed or -lobed.

(d) *Grain*

The hilum is punctiform and basal.

Cytology and Cytogenetics

Avdulov's (1931) pioneer work on the cytology, anatomy and morphology of the grasses has been of great importance to those whose studies include the systematics and phylogenetic relationships of the Gramineae. This original work and research lead him to divide the family into two large groups, *Sacchariferae* and *Poatae*. The

latter were again subdivided into *Phragmitiformes* and *Festuciformes*. Both *Saccharif erae* and *Phragmitiformes* have small chromosomes, the former in multiples of 9 or 10, and the latter in multiples of 12. The *Festuciformes*, however, have large chromosomes with a basic number of 7.

When Avdulov came to examine the *Festuciformes* in detail, he found that the vast majority of those included in this group were inhabitants of the temperate or cooler regions of the world. From this and other considerations he propounded the hypothesis that the evolutionary trend in the grasses was towards a reduction in chromosome number but an increase in chromosome size—a hypothesis which has had a large measure of acceptance. He took the view that the phylogenetic increase in size of the chromosomes was brought about as an adaptation to the more rigorous climate in which these grasses live.

In common with most of the genera which inhabit temperate or cold climates, the basic chromosome number in the genus *Poa* is 7. The genus can also be considered to be advanced in that the species, *inter alia*, have specialised appendages in the form of the wool at the base of the lemmas, and often hairy coverings to the lemmas themselves. It is therefore something of an anti-climax to find that the chromosomes in the genus are small, in fact much smaller than in other members of the *Festuciformes*. Stebbins (1950) considers this circumstance to provide the best evidence among plants for the reversibility of trends in absolute chromosome size.

Since no Indian cytologist has worked on the Indian species of *Poa*, the work of Russian, American and British scientists on those species which are cosmopolitan and which are also found in India, has been taken as the basis for the following short account.

Reference may be made to an excellent review of the whole subject by Myers (1947), whose index to the literature contains over 600 references.

Polyploidy is a feature of the Gramineae and the genus *Poa* is one of the genera which provides perhaps one of the best illustrations of this statement.

Not only is polyploidy common in this genus, but several of the species include races which differ in chromosome number, as will be evident from the following list of species, all of which occur in India :—

		2n
Poa annua Linn.	...	28
P. supina Schrad	...	14
P. infirma H.B.K.	...	14
P. bulbosa Linn.	...	28
P. tibetica Munro	...	56
P. sterilis M.B.	...	28, 42
P. nemoralis Linn.	...	28, 42
P. palustris Linn.	...	28, 42
P. alpina Linn.	...	32-34, 42, 22-38, ±31, 22, 23, 24, 25, 31.
P. compressa Linn.	...	35, 42, 49, 56.
P. pratensis Linn.	...	28, 56, 70, 49-85, 50-87, ±1, 66, 67, 41± to 64, 48-72, 28-114, 18, 40, 42, ±72.

The most important effect of polyploidy is the genetic barrier which immediately comes into being between a polyploid and its diploid progenitor (Stebbins). Apart from this there are morphological as well as physiological changes about which there is considerable difference of opinion.

Actually it is difficult to generalise about these matters and according to Stebbins the only safe generalization which can be made about morphological and physiological changes as a result of polyploidy is that they depend greatly upon the original genotype !

On the other hand, some authors hold that the alteration in chromosome number from diploidy to tetraploidy and hexaploidy leads generally to an increase in plant and organ size. Any further increase in chromosome number means either no increase in plant size or, in some instances, a diminution.

With regard to ecological conditions and particularly to extreme conditions, there is some evidence which seems to indicate that polyploidy confers certain benefits upon the plant. It is believed by some authors that polyploidy actually means the acquisition of new genetical and morphological characters, whereby the migration of the plant into areas where the conditions for plant life are more exacting, is facilitated.

In areas where drought, insolation, ice and snow are the controlling factors, the proportion of polyploids in the plant population is high. It has been found that in those species in which diploids and polyploids occur, the polyploids prefer a more northern and alpine habitat than the diploids.

As an example the mountains of the Pamir (a continuation of the Karakoram Himalaya through the Hindu Kush) and the Altai (Central Russia) can be taken. Two Russian botanists, Sokolovskaya and Strelkova (1940), found that the proportion of polyploids in the species studied (mostly *Gramineae*) was 85 per cent. for the former and 65 per cent. for the latter. It may be added that the conditions for plant life in the Pamir are far more exacting than in the Altai. Further, in the Arctic, polyploids account for about 80 per cent. of the plants studied by Flovik (1940).

Polyploids, which have arisen as hybrids between races or subspecies of a species, are known to possess a toleration of edaphic and climatic conditions which are greater than those of either of the parents. The same is true of allopolyploids. Such polyploids, then, do possess characteristics which enable them to colonise habitats which are beyond the range of the parents.

Apomixis

Included in this term are proliferation (sometimes called vivipary) and agamospermy. As far as is known no critical investigation has been carried out on proliferation, considered as a form of apomixis, but Arber was of opinion that the number of instances in which proliferation gave rise to new plants must be small indeed. On the other hand the fact that *P. bulbosa* L. is exceedingly common in the Himalaya and that proliferation seems to occur in every inflorescence, it is possible that the production of new plants from viviparous inflorescences is much higher than it is thought to be. At any rate, out of many

hundreds of plants seen, only in one case did it appear that the inflorescence was normal. In India proliferation has been noticed, apart from *P. bulbosa*, in *P. alpina* and a dubious case of *P. pratensis*. Among other members of the *Bulbosae* (*P. bactriana*, *P. glabriflora* and *P. sinaica*) this condition does not appear to occur.

Agamospermy is common in the genus *Poa* and extensive studies on this phenomenon have been carried out, especially in the species *P. pratensis* and *P. alpina*. Apomixis was first suspected in *P. pratensis* because parent plants with aneuploid chromosome numbers produce morphologically uniform progenies with the same chromosome number (Müntzing). In subsequent investigations it was shown for *P. pratensis* that there is almost a complete series of forms which range from almost entirely apomictic to completely or almost completely sexual. The cytological basis for apomixis in *P. pratensis* was discovered by Åkerberg (1939, 1942, 1943). It was found that aposporic apomixis took place in which the embryo sac developed from a cell of the nucellus without fertilisation. Generally the products of meiosis degenerated and disappeared and were replaced by the aposporous embryo sac. The development of the embryo is independent of fertilisation but pollen is an absolute necessity before there is any formation of endosperm. One remarkable result of this research was the discovery that the pollen of *P. alpina* can bring about the formation of endosperm equally well with that of *P. pratensis*.

In *P. alpina* meiosis has not been observed in apomictic biotypes, the first division of the macrospore mother cell being mitotic. In this species pseudogamy also occurred. The development of the embryo started without fertilisation, but endosperm development was dependent upon fertilisation of the polar nuclei (Håkansson 1944).

The progeny test, carried out on *P. compressa*, indicates that it, too, reproduces, at least in part, by agamospermy on the same basis as *P. alpina*.

That the cause of apomixis is to be ascribed to genetic factors seems to be indicated by the work of Müntzing (1940). In crossing sexual and apomictic forms of *Poa* he obtained types which were predominantly sexual, showing that apomixis is recessive to sexuality. Hybrids obtained from a cross between two apomictic parents *P. pratensis* and *P. alpina* were themselves sexual. Similar results were obtained when *P. compressa* and *P. pratensis* both highly apomictic, were crossed. In this case both the F_1 and F_2 generations were also sexual.

Classification

It is not the writer's intention to attempt to provide a new system of classification of the subdivisions of *Poa*. No published system has so far been accepted in its entirety, nor is a thoroughly reliable system likely to emerge until there has been a complete study of the genus as a whole, particularly in the field.

What follows is merely a grouping of the species treated in this work into what seems to the writer to be their probable relationships. Since any logical classification must take into consideration the life habit of the species, a characteristic which cannot be accurately or completely deduced from herbarium specimens, it is quite certain that

the following proposals will eventually become modified or upset altogether as knowledge of the genus increases.

Until that stage is reached, the following may serve as a basis for criticism, and perhaps provide the stimulus to produce something better.

I. Ochlopoa

Annuals or caespitose perennials; glumes ± unequal in length, the lower the smaller, 1-nerved, the upper 3-nerved; lemma and glumes mostly thin; anthers usually small; keels of palea pilose, rarely semipilose or scabrid; leaves broad, flaccid, green.

1. *P. tibeticola* Bor.
2. *P. infirma* H.B.K.
3. *P. nepalensis* Wall.
4. *P. nephelophila* Bor.
5. *P. supina* Schrad.
6. *P. annua* Linn.
7. *P. sikkimensis* Bor.
8. *P. stapfiana* Bor.

II. Himalayenses

Slender perennials; glumes unequal; the lower very narrow, 1-nerved, the upper 3-nerved; lemmas conspicuously 5-nerved; wool copious to absent; anthers less than 1 mm. long; keels of palea scabrid, rarely semi-pilose; ligule over 1 mm. long; rhachilla smooth, rarely warty.

9. *P. himalayana* Nees.
10. *P. stewartiana* Bor.
11. *P. khasiana* Stapf.
12. *P. wardiana* Bor.

III. Nemorales

Slender perennials; lower glume awl-shaped, 1–3-nerved, upper 3-nerved; lemmas hyaline at tip and on the margins; anthers over 1 mm. long; ligules very short, less than 1 mm. long; leaves narrow; rhachilla minutely hairy.

13. *P. nemoralis* Linn.
14. *P. polycolea* Stapf.
15. *P. aitchisonii* Boiss.

IV. Setulosae

Tufted perennials; glumes awl-shaped, setulose, 1-nerved, much longer than the lemmas; anthers less than 1 mm. long.

16. *P. setulosa* Bor.

V. Steriles

Caespitose perennials; panicles effuse or contracted; glumes ± equal in length, narrowly or broadly elliptic, both 3-nerved; lemmas

indistinctly 5-nerved, hyaline at the tip with usually a yellow band below, rarely silky on the dorsal surface, rhachillas minutely verrucose to hairy.

17. *P. sterilis* M.B.
18. *P. araratica* Trautv.
19. *P. litwinowiana* Ovcz.
20. *P. lahulensis* Bor.

VI. Palustres

Caespitose perennials; glumes thin, subequal, the lower 1-, the upper 3-nerved; lemmas thin, inconspicuously nerved; wool present, often plentiful; rhachilla shortly and minutely hairy; leaf-blades flat, dark green, abruptly tapering to a point.

21. *P. palustris* Linn.

VII. Triviales

Perennials with stolons; glumes small, curved on the back; lemmas firm, distinctly 5-nerved; ligules long, pointed; leaves thin, soft, tapering; sheaths, particularly the lower, harsh to the touch, rarely smooth.

22. *P. trivialis* Linn.

VIII. Stoloniferae

Perennials with scaly, long-noded rhizomes; glumes ± unequal, the lower 1-, the upper 3-nerved; lemmas firm, conspicuously 5-nerved; wool usually very copious: keels of palea scabrid; anthers linear, long; leaves rather firm, hooded.

23. *P. alpigena* (Blytt) Lindm.
24. *P. angustifolia* Linn.
25. *P. asperifolia* Bor.
26. *P. jaunsarensis* Bor.
27. *P. pratensis* Linn.

IX. Tichopoa

Perennials, with extensively creeping rhizomes; stems compressed; glumes ± equal, the lower 1-, the upper 3-nerved; lemmas very obtuse, firm, inconspicuously 5-nerved; wool rather scanty; leaves flat.

28. *P. compressa* Linn.

X. Lanatiflorae

Perennials; panicles spreading; spikelets large; lower glume 1-rarely 3-nerved, upper 3-nerved; lemmas conspicuously 5-nerved, often broadly hyaline on the margins, hairy on the lower surface in the lower half, rarely only scabrid; anthers generally large; leaves broad to very broad, flat.

29. *P. pagophila* Bor.
30. *P. falconeri* Hook. f.
31. *P. nitide-spiculata* Bor.

32. *P. gammieana* Hook. f.
33. *P. eleanorae* Bor.
34. *P. burmanica* Bor.
35. *P. ludens* Stewart.
36. *P. gamblei* Bor.

XI. Glabratae

Densely tufted perennials; glumes ± equal, the lower 1–3-nerved, the upper 3-nerved; lemmas somewhat firm, almost quite glabrous, shining, with inconspicuous nervation; wool present or absent; leaf-blades flat, plicate or very narrow; anthers minute to 1·5 mm. long.

37. *P. amoena* Bor.
38. *P. poophagorum* Bor.
39. *P. phariana* Bor.
40. *P. rhadina* Bor.

XII. Paucidentatae

Perennials rhizomatous with basal nodes closely crowded; glumes and lemmas thin, very broad, rounded or very obtuse, curved on the back; lemmas obscurely 5-nerved; paleas with a few blunt teeth on the keels; leaves plicate, tapering abruptly to a stout point.

41. *P. calliopsis* Ovcz.

XIII. Alpinae

Perennial grasses with basal nodes close together; spikelets broadly elliptic-ovate; glumes broad, both 3-nerved, curved on the back: lemmas silky-hairy on the dorsal surface, curved on the keel; keels of the palea semi-pilose, rarely scabrid; leaves flat, tapering abruptly to a point, nearly all collected at the base of the plant.

42. *P. alpina* Linn.
43. *P. hirtiglumis* Hook. f.
44. *P. koelzii* Bor.
45. *P. tibetica* Munro.

XIV. Bulbosae

Perennials with culms bulbous at the base; glumes ± equal, broad, the lower 1-, the upper 3-nerved, scarious; lemmas rather firm, very variable in the matter of cilia and wool; leaves very narrow, filiform to flat and somewhat rolled.

46. *P. glabriflora* Roshev.
47. *P. bactriana* Roshev.
48. *P. sinaica* Steud.
49. *P. bulbosa* Linn.

POA Linn.

Spikelets 2–7-(rarely 1- or 9-) flowered, in loose, spreading or contracted, sometimes almost spike-like, panicles; rhachilla disarticulating above the glumes and below each floret, smooth and glabrous or minu-

tely warty or hairy, rarely pilose below, usually continued beyond the topmost floret and crowned by a rudimentary floret; florets hermaphrodite or the upper imperfect. *Glumes* usually shorter than the lemmas, occasionally longer, more or less equal in length, membranous, green or more or less suffused with purple, keeled, acute, acuminate or rarely obtuse, 1–3-nerved, with a broad or narrow hyaline margin, smooth and glabrous or rarely sparsely scabrid on the dorsal surface near the tip, usually scabrid on the upper half of the keel. *Lemmas* varying in texture from thinly membranous to almost coriaceous, obtuse, acute or rounded at the tip, green or suffused with purple, with or without a yellow band below the hyaline tip, keeled, faintly or conspicuously 5-nerved, smooth or more often scabrid on the upper half of the keel, more rarely scabrid on the dorsal surface near the tip or all over, hyaline at the tip and along the margins, ciliate on the lower half of the keel and lateral nerves, rarely on all the nerves, glabrous on the dorsal surface below between the nerves or with a more or less thick covering of white matted hairs in the lower half or all over, very rarely entirely glabrous; often punctate or granular all over the dorsal surface, especially when the lemmas are of firmer texture; *callus* small, obtuse, distinct, often carrying a tuft of long wool. *Paleas* usually shorter than the lemmas, occasionally longer, hyaline, 2-keeled, hairy or glabrous between the keels, punctate or not on the flaps and/or between the keels, dentate, scabrid, spinulose, ciliate, or almost smooth on the keels or scabrid above and ciliate below. *Lodicules* 2, more or less 2-toothed or 2-lobed. *Stamens* 3; anthers very minute up to 3 mm. long, purple or yellow. *Ovary* glabrous; styles short, distinct; stigmas plumose, laterally exserted. *Grain* linear, free or adherent to the palea. *Hilum* punctiform, basal.

Annual or perennial grasses, the latter with rhizomes or stolons or both. *Culms* terete or rarely compressed, erect or decumbent below, sometimes with a bulbous thickening at the base, often densely tufted, smooth or scabrid beneath the panicle. *Leaf-blades* flat and flaccid or firm, sometimes plicate or convolute and threadlike, smooth or scabrid, often abruptly contracted to a firm scabrid tip or hooded; *sheaths* smooth or scabrid; *ligules* hyaline to membranous, pointed to rounded, lacerate or entire, almost absent to 7 mm. long, occasionally scabrid on the outer surface. Panicle branches often whorled or single, usually scabrid, rarely smooth; pedicels always scabrid.

This genus is a large one of well over two hundred species which are world-wide in distribution. The species are found in all temperate or cold climates, irrespective of whether these climates are due to geographical position or high altitude. A few species are cosmopolitan. In the Himalaya the vertical limits between which species of *Poa* are found, is 800 m. to 6,500 m.

How to use the key

The characters by which the individual species are separated are duration of life, habit, shape and size of the spikelets and their separate parts and the nature of the keels of the palea. It has not been found possible to draw up a key containing only characters which are visible to the naked eye—a lens and dissection are necessary to be certain of a correct determination. Those who spend months on the genus, do,

with time, acquire a certain facility in separating the species by eye, but the systematist who wishes to name a collection or a single specimen cannot be expected to know all the species by sight.

The grass to be identified must first of all be carefully examined in order to find out if there is a bulbous thickening at the base or not. Is the plant a perennial or annual, is it tufted or does it possess stolons or rhizomes, or both? Find out if the culm is smooth or scabrid below the inflorescence and if it is terete or compressed. Are the lower sheaths smooth or scabrid? Measure the length of the ligule of the *topmost* leaf. Before dissection of the spikelet, there are two things to find out (*a*) the shape of the spikelet—is it ovate or some other shape? and (*b*) the position of the tip of the lower glume in relation to the mid-point of the lower lemma as it is in the untouched spikelet. Find out whether the tip of the lower glume equals or exceeds this point or whether it definitely does not reach it. The nervation of the lower glume is important—it may be 1–3—nerved. Is the upper glume ciliate on the margins below? Examine the lemma—is the tip broadly rounded, obtuse—acute or even apiculate—is the keel strongly curved or straight in profile—are the nerves faint or conspicuous—is the dorsal surface, apart from the nerves and keel, scabrid, glabrous, hairy, 'granular or glandular-punctate'—are the nerves and keel glabrous or ciliate? Is the connecting wool at the base on the callus copious or sparse or is the callus quite glabrous? Measure the length of the stamens. Examine the keels of the palea. Are they smooth or scabrid above and ciliate below or are they ciliate all along or are they almost smooth with a very few hooked teeth above? It is advisable to soak the palea in water as the cilia sometimes do not become visible until they are teased out. Is the rhachilla smooth, glabrous, scabrid, pilose or verrucose?

The terms 'granular, gland-dotted, glandular-punctate' used above describe an impression given by the surface of some lemmas or on occasion, the palea, when viewed through a lens. The surface looks as if it were pitted, and the pits when viewed at a certain angle seem to glisten. These seemingly pit-like structures, are not glands but the silica cells, which by refraction of light at certain angles, give the illusion of pits. The *Pratensis* group of Poas shows this particularly well. It is advisable to use a power greater than ×10 to obtain the best effect.

Key to the species of *Poa*

Stems with a bulbous thickening at the base:—

Lemmas entirely glabrous:—

Panicle contracted; 1·5 cm. long, 5 mm. broad; branches very short; spikelets congested; very slender grass, up to 15 cm. tall ... 46. *P. glabriflora*

Panicle spreading, 4–6 cm. long, 15–20 mm. broad; branches up to 3 cm. long, spreading; plants up to 40 cm. tall ... 47. *P. bactriana*

Lemmas with some hairs at least on side nerves and keel:—

Lemmas 3·5–4 mm. long; spikelets rarely show proliferation; a grass of dry arid places ... 48. *P. sinaica*

Lemmas 2·5–3 mm. long; spikelets almost always exhibit proliferation; a mesophytic grass ... 49. *P. bulbosa*

Stems without any thickening at the base :—

Lemmas with a hairy covering on the dorsal surface between the nerves, often this reduced to a few hairs at the base of the lemma and dorsal surface of lemma coarsely scabrid, rarely shiny :—

Spikelets ovate in outline; base thick due to numerous short persistent leaf-sheaths; keels of the palea long ciliate below ... 42. *P. alpina*

Spikelets oblong, elliptic, lanceolate or wedge shaped :—

Inflorescence a spreading panicle :—

Lower glume equal to or longer than the lowest lemma in the spikelet :—

Lemmas hairy all over the dorsal surface; lowest lemma 2·5 mm. long; spikelets 4·5 mm. long ... 43. *P. hirtiglumis*

Lemmas hairy in lower half or less; lowest lemma 4 mm. long; spikelets 6·5 mm. long ... 33. *P. eleanorae*

Lower glume distinctly shorter than lowest lemma :—

Upper ligules short, under 1·5 mm. long :—

Tufted grasses; lower glume awl-shaped in profile:—

Keels of the palea ciliate in the lower half; margins of lemmas and glumes narrowly hyaline; basal sheaths disintegrating into brownish fibres; spikelets up to 5 mm. long; anthers 1 mm. long; wool copious ... 34. *P. burmanica*

Keels of the palea scabrid, margins of lemmas and glumes broadly hyaline; basal sheaths many, scarious, straw-coloured; spikelets up to 7 mm. long; anthers 2–2·5 mm. long; wool scanty ... 14. *P. polycolea*

Not tufted; lower glume lanceolate, not awl-shaped; anthers 2-3 mm. long, leaves and sheaths crowded at base of culm; glumes and lemmas finely granulate ... 35. *P. ludens*

Upper ligules longer, over 1·5 mm. long.
Lemmas very broadly hyaline; spikelets pale; basal sheaths scarious; rhachilla joints not conspicuous ... 14. *P. polycolea*

Lemmas not very broadly hyaline, often purple; basal sheaths not scarious: rhachilla joints sometimes conspicuous from side:—
Lemmas more or less scabrid or dull all over the dorsal surface; ligule 2–3·5 mm. long or more; hairy covering of the lemma often reduced to a few hairs at the base:
Very slender grass, basal leaves setaceous; rhachilla joints not conspicuous from the side; upper glume 3–3·5 mm. long; lemma 4–4·5 mm. long ... 29. *P. pagophila*

Robust grass; basal leaves flat; rhachilla joints very conspicuous from side; upper glume 4·5–5 mm. long; lemma 4–5 mm. long 30. *P. falconeri*

Lemmas smooth, sometimes shining, on the dorsal surface, but often glandular punctulate; ligule up to 5 mm. or more:—
Keels of the palea scabrid:—
Anthers over 2 mm. long; wool present on callus:—
Glumes and lemmas broadly hyaline on the margins; plants grey-glaucous; lemmas 6 mm. long ... 31. *P. nitidespiculata*

Glumes and lemmas not broadly hyaline, plant green; lemmas 4·5–5 mm. long ... 30. *P. falconeri*

Anthers under 2 mm. long:—
Wool absent; lemmas 3·5–5·5 mm. long: paleas scabrid or semi-pilose on the keels:—
Leaves narrow, 2·5 mm. broad; keels of palea scabrid ... 25. *P. asperifolia*

Leaves broad, 7 mm. broad; keels of palea semi-pilose 32. *P. gammieana*

Wool present, very copious; lemmas about 2·5 mm. long; paleas ciliate on the keels 3. *P. nepalensis*

Keels of the pales ciliate below :—

Sheaths smooth; leaves narrow, 30 times as long as broad; panicle long exserted; ligule membranous, up to 5 mm. long; lemmatal nerves not particularly prominent; lower lemma at most 4 mm. long; a western species ... 8. *P. stapfiana*

Sheaths scabrid or asperulous; leaves broader, 10 times as long as broad acuminate; panicle not long exserted; ligule up to 4 mm. long; lemmatal nerves very prominent; lowest lemma 4·5–5 mm. long; an eastern Himalayan species ... 32. *P. gammieana*

Inflorescence contracted, dense, at most 6 cm. long, 1 cm. broad :—

Dwarf plants not above 15 cm. tall, very glaucous or not glaucous; keels of palea semi-pilose; wool present ... 44. *P. koelzii*

Much taller as a rule, not glaucous; palea shortly semi-pilose, cilia often reduced to a few hairs, scabrid above; wool absent or very sparse ... 20. *P. lahulensis*

Lemmas not hairy between the nerves but occasionally scabrid (*P. himalayana*) :—

Anthers 2 mm. long or over :—

Ligules short not over 2 mm. long; lemmas prominently 5-nerved :—

Lemmas completely glabrous :—

Lemmas 5·5 mm. long, scabrid ... 36. *P. gamblei*

Lemmas not above 4 mm. long, smooth ... 15. *P. aitchisonii*

Lemmas ciliate on keels and side nerves, smooth; rhachilla joints conspicuously long; lower glume very narrow ... 14. *P. polycolea*

Ligules longer, 2·5–4·5 mm. long; lemmas inconspicuously 5-nerved :—

Panicle contracted; branches erect; lemmas smooth pale; margins of upper glume cilitae below ... 45. *P. tibetica*

Panicle lax; branches spreading; margins of upper glume eciliate :—

Lemmas scabrid, broadly hyaline; glumes and lemmas very dull, green or purplish. 29. *P. pagophila*

Lemmas smooth, hyaline on margins; glumes and lemmas shining, pale or yellowish; lemmas often with a yellow streak below hyaline portion ... 17. *P. sterilis*

Anthers under 2 mm. long :—
Wool present on the callus :—
Ligules short not more than 1 mm. long; keels of palea scabrid :—
Lower glume lanceolate, 1-nerved, 2–2·5 mm. long; lemmas almost glabrous, hyaline at the tip only, distinctly 5-nerved ... 11. *P. khasiana*

Lower glume awl-shaped, 3-nerved, 2·5–3 mm. long; lemmas ciliate on the keel and side nerves; hyaline in upper quarter, faintly 5-nerved ... 13. *P. nemoralis*

Ligules over 1 mm. long; or if less keels of palea semi-pilose or ciliate :—
Keels of palea ciliate below, scabrid above ... 10. *P. stewartiana*

Keels of palea either scabrid or ciliate throughout :—
Keels of palea ciliate throughout :—
Panicle branches whorled in 4's; keel and lateral nerves of lemma ciliate; wool scanty; leaves up to 5 mm. broad; panicle green ... 4. *P. nephelophila*

Panicle branches in pairs; keel and lateral nerves of lemmas densely ciliate; wool copious; leaves up to 4 mm. broad; panicle silvery ... 3. *P. nepalensis*

Keels of palea scabrid throughout :—
Stems and sheaths compressed; side nerves of lemma obscure; spikelets rather crowded in the panicle... 28. *P. compressa*

Stems and sheaths terete :—
Lower sheaths scabrid :—
Ligule long, pointed, more than 1·5 mm. long; panicle in distinct whorls of 4–6 (usually 5); side nerves of lemma prominent; inflorescence spreading; base not curved ... 22. *P. trivialis*

Ligule short, just over 1 mm. long; panicle branches in 2's or alternate : lemmatal nerves obscure; panicle compact; base curved ... 23. *P. alpigena*

Lower sheaths smooth :—
Lemmas very broad, rounded on back and hyaline at the tips:—
Lemmas strongly compressed, up to 3·75 mm. long; palea scabrid with many teeth; a dwarf plant not more than 4 cm. tall; panicle glabose compact; spikelets dark purple ... ... 39. *P. phariana*

Lemmas rounded on the back; palea with distant teeth on the keels; up to 10 cm. tall, with long reflexed panicle-branches; spikelets suffused gold and purple or green ... 41. *P. calliopsis*

Lemmas not broad; acute or narrowly obtuse at the tip :—
Lowest branches of the panicle 3–5-nate; grasses with shortly or extensively creeping rhizomes or short or long stolons :—
Perennials, loosely or densely tufted, with short stolons; ligules acute or obtuse; side nerves of the lemmas obscure or prominent:—
Ligules pointed, 3–4 mm. long; side nerves of the lemmas very prominent; lemmas green:—
Stems and basal sheaths scabrid ... 22. *P. trivialis*

Stems and basal sheaths smooth ... 22. *P. trivialis* f. *glabra*

Ligules rounded 3 mm. long; side nerves of the lemmas very obscure; lemmas with a brown or copper streak below the hyaline tip ... 21. *P. palustris*

Perennials with widely creeping rhizomes forming scattered vegetative shoots or culms or tufts

of these ; ligules truncate ; side nerves of the lemmas very conspicuous :—

Plants erect from the base :—

Basal leaves narrow, almost setaceous ; lemmas 2·5–3 mm. long ... 24. *P. angustifolia*

Basal leaves broad, flat; lemmas 3–4·5 mm. long :—

Ligules not more than 2 mm. long ; lemmas 3–3·5 mm. long ... 27. *P. pratensis*

Ligules 2·5–6 mm. long; lemmas 3·5–4·5 mm. long ... 26. *P. jaunsarensis*

Plants conspicuously curved at the base ... 23. *P. alpigena*

Lowest branches of the panicle 2-nate, occasionally 3-nate; plants non-rhizomatous or with a thick horizontal or inclined rootstock (*P. araratica*):—

Lower glume equal to or longer than the lowest lemma :—

Panicle spreading ; glumes acute not acuminate or subulate :—

Lemmas 2·25–2·5 mm. long ... 40. *P. rhadina*

Lemmas 5–6 mm. long 33. *P. eleanorae*

Panicle very narrow, linear-oblong with ascending branches: glumes subulate in profile ... 16. *P. setulosa*

Lower glume definitely shorter than the lowest lemma :—

Panicle narrow :—

Plants very glaucous ... 19. *P. litwinowiana*

Plants not at all glaucous :—
Branches not more than 2 cm. long; spikelets elliptic or lanceolate usually suffused with violet, base of plant reddish mauve; rhizomatous, rootstock stout ... 18. *P. araratica*
Branches over 3 cm. long; spikelets wedge-shaped, green or yellowish green; lemmas broadly hyaline on the margins: plants green or pale at the base; no stout rootstock ... 17. *P. sterilis*
Panicle spreading :—
Lemmas quite glabrous; broadly hyaline on the margins ... 15. *P. aitchisonii*
Lemmas at least ciliate on the keel and nerves; narrowly or broadly hyaline on margins and at the tip.
Lower glume reaching half-way up the lowest lemma or less; lemmas 4–4·5 mm. long; lowest branches of panicle 2-nate ... 9. *P. himalayana*
Lower glume longer than half the lowest lemma; lemmas 3–4 mm. long :—
Lemmatal nerves conspicuous; lower glume very narrow, 1-nerved; spikelets green; lowest branches of the panicle 3–5-nate ... 11. *P. khasiana*

Lemmatal nerves faint; lower glume lanceolate or elliptic, 3-nerved; spikelets yellowish green; lowest branches of the panicle 2-nate ... 17. *P. sterilis*

No wool on the callus :—

Ligules less than 1 mm. long ... 11. *P. khasiana*

Ligules over 1 mm. long :—

Keels of the palea ciliate below, scabrid above ... 7. *P. sikkimensis*

Keels of the palea either ciliate or scabrid throughout :—

Keels ciliate :—

Intermediate nerves of lemma glabrous; anther 1·2–1·6 mm. long ... 5. *P. supina*

All nerves of the lemma hairy; anthers less than 1 mm. long :—

Anthers 0·2–0·3 mm. long; upper floret markedly dissimilar to the lower ... 2. *P. infirma*

Anthers 0·6–0·8 mm. long; upper floret similar to the others ... 6. *P. annua*

Keels of palea scabrid :—

Culms scabrid below the panicle :—

Lemmatal nerves conspicuous; lemmas scabrid; anthers less than 1 mm. long ... 12. *P. wardiana*

Lemmatal nerves obscure; lemmas smooth; anthers over 1·5 mm. long :—

Spikelets wedge-shaped, 5–6 mm. long, 4–several-flowered; panicle widely spreading; lemma broadly hyaline at the tip, narrowly so on the margins, obtuse, sparsely pubescent on the nerves; a yellowish band present below the hyaline tip; panicle ± lax; culms 30–60 cm. tall; plant green ... 17. *P. sterilis*

Spikelets elliptic or lanceolate, 2–3(4)-flowered, 4–5 mm. long; panicle of closely crowded spikelets; lemmas not broadly hyaline, usually acute, marked-

ly pubescent on the nerves; no yellowish band below the tip; plants very glaucous, up to 30 cm. tall ... 19. *P. litwinowiana*

Culms smooth below the panicle :—
Culms strongly compressed ... 28. *P. compressa*

Culms terete :—
Glumes usually equal to or longer than lowest lemma; if shorter, then base covered with long scarious sheaths; panicle strict, shortly exserted ... 37. *P. amoena*

Glumes definitely shorter than lowest lemma; basal sheaths not long scarious; panicle usually long exserted :—
Lemmas quite glabrous on dorsal surface; inflorescence a narrow linear panicle ... 38. *P. poophagorum*

Lemmas with at least keel and side nerves ciliate :—
Inflorescence a spreading panicle :—
Spikelets up to 6 mm. long; lemmas 3·5–3·75 mm. long; anthers 2–2·5 mm. long ... 15. *P. aitchisonii*

Spikelets up to 3·25 mm. long; lemmas 2–2·5 mm. long; anthers 0·4–0·5 mm. long ... 1. *P. tibeticola*

Inflorescence a strict panicle ... 38. *P. poophagorum*

I. Ochlopoa

1. **Poa tibeticola** Bor, in Kew Bull. **1948** : 139, 1948.

An annual or perennial (?) grass with very leafy, slender stems. *Culms* from a few centimetres up to 25 cm. tall, 0·3 mm. in diameter just below the panicle, very smooth and glabrous, erect or shortly geniculate at the base, covered below with the remains of earlier leaf sheaths; nodes smooth and glabrous, becoming visible as the sheaths slip from the culm. *Leaf-blades* soft and flaccid, up to 25 cm. long by 2 mm. broad, linear-acuminate in shape, tapering gradually to a very firm, scabrid, stout tip, contracted abruptly at the base to the sheath,

cartilaginous on the margins, smooth in the central portion and armed with antrorse teeth at the tip and retrorse teeth at the base, very minutely scabrid on the nerves on both surfaces, distinctly veined *Sheaths* rather loose, the lowest slipping from the culm and disintegrating into fibres, the central somewhat inflated while the uppermost clasps the stem firmly, very striate, scabrid on the nerves with downwardly directed teeth. *Ligule* membranous, erose at the tip, scabrid on the outside, 2–3 mm. long.

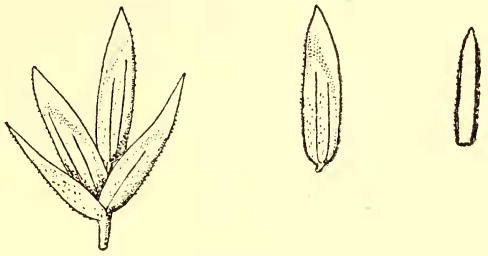


Fig. 1. *Poa tibeticola* Bor, × 10

Inflorescence an oblong panicle up to 10 cm. long by 5 cm. broad, very delicate ; axis smooth and glabrous or very minutely scabrid below; branches about 1 cm. long, capillary, very flexuous, coarsely scabrid, for the most part binate at the nodes, sometimes 3-nate ; branchlets short, coarsely scabrid, sparsely branched, carrying a small number of spikelets. *Spikelets* 2–3-flowered, seated on short scabrid pedicels, up to 3·25 mm. long, elliptic-oblong in shape ; florets diverging at anthesis. *Lower glume* 1·5–3 mm. long, 0·8 mm. in width, lanceolate- or oblong-acuminate in shape when flattened, narrowly hyaline along the margins, curved or almost straight on the keel in profile, 1–3-nerved, scabrid on the keel, covered on the dorsal surface with asperities in the upper third or upper two-thirds. *Upper glume* 2–2·25 mm. long, 1 mm. wide, elliptic- or ovate- or lanceolate-acuminate or -acute when flattened, slightly curved on the back, 3-nerved, hyaline on the margins up to the lateral nerves, scabrid on the keel, covered with asperities on the dorsal surface in the upper two-thirds. *Lowest lemma* 2 mm. long or little longer, oblong-obtuse or broadly elliptic-obtuse in shape, often erose at the hyaline tip, hyaline along the margins, distinctly 5-nerved, scabrid on the keel to the base and along the lateral and intermediate nerves, covered on the dorsal surface with asperities, or free from asperities and minutely glandular-punctate in the lower half, no trace of cilia on the keel and lateral nerves. *Rhachilla* minutely scabrid, produced beyond the topmost floret and covered with a rudimentary floret. *Anthers* minute 0·4–0·5 mm. long. *Wool* absent. *Palea* shorter than the lemma, scabrid on the keels.

Tibet: Khambajong, 7 Sept. 1903, *Younghusband* 304; Lhasa, Sept. 1904 *Walton*.

Sikkim: Chugyu, 5,000 m., 12 Sept. 1912, *Rohmoo Lepcha* 284.

A very delicate species with minute spikelets which are perfectly glabrous without a trace of cilia or wool. The keels of the palea are scabrid. The specimen from Chugyu is not more than 3 cm. tall.

2. **Poa infirma** H.B.K., Nov. Gen. et Sp. 1 : 158 (1815) 27.

P. exilis (Tomm.) Murb. in Ascher. et Graebn., Syn. Mitteleurop. Flora 2: 389 (1900).

P. remotiflora Murb., Contrib. Flor. nor.-ous. Afr. 4: 2? (1900).

P. annua Linn., ssp. *exilis* Tomm. apud Freyn. Zool.-Bot. Ges. 27: 469 (1877).

Catabrosa thomsoni Stapf ex Hook. f., Flor. Brit. Ind. 7: 311 (1896).

A strictly annual grass. *Culms* rather slender and weak, smooth and glabrous, up to 10 cm. tall, occasionally twice as tall, sheathed almost to the inflorescence. *Leaf-blades* soft, flaccid, linear, abruptly contracted to a blunt point, up to 6 cm. long, 5 mm. broad, scabrid on the margins and on the midrib below, very scabrid at the tip, very thin. *Sheaths* rather loose, herbaceous, smooth and glabrous, somewhat inflated at the base of the plant. *Ligule* membranous, entire, 1–2 mm. long, rounded or obtuse at the tip.

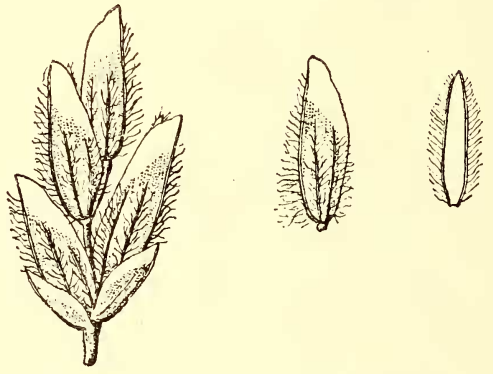


Fig. 2. *Poa infirma* H.B.K., × 10

Inflorescence a narrow, oblong, rather open panicle with branches ascending, rarely horizontal, and never deflexed; axis smooth and glabrous, angled; branches smooth and glabrous, in pairs, often a longer accompanied by a shorter, up to 2 cm. long, carrying rather remote spikelets at anthesis. *Spikelets* 4–4·5 mm. long, 3–5-flowered, oblong-obtuse in shape, with remote florets which occasionally hide the joints of the rhachilla, seated, except the terminal, on very short pedicels. *Lower glume* 1·25 mm. long, 0·6 mm. wide, oblong-acute in shape, slightly curved on the back, broadly hyaline on the margins, smooth and glabrous. *Upper glume* 1·5 mm. long, 1 mm. wide, broadly elliptic-obtuse in shape when flattened, very broadly hyaline on the margins and at the tip, 3-nerved, smooth and glabrous. *Lemma* 2·5 mm. long, 1·5 mm. wide, widest above the middle, oblong-ovate-obtuse or almost round at the tip, herbaceous in texture, faintly 5-nerved, very broadly hyaline at the tip and along the margins, almost straight on the back, thickly ciliate on all nerves or occasionally thinly ciliate. Wool absent. *Rhachilla* produced and carrying a rudimentary spikelet, smooth and glabrous. *Anthers* minute, 0·22–0·33 mm. long. *Palea* shorter than the lemma, long ciliate on the keels.

Ind. Or.: Rawalpindi, 21 April 1930, *R. R. Stewart* 10755; Dehra Dun, Robber's Cave, 780 m., 29 Feb. 1928, *Umras Singh* 317.

Tibet: Bilaspur, *Duthie* s.n.; Nubra Valley, 3–3,500 m., *T. Thomson.*

This delicate little species is comparatively rare, having been collected on four occasions only. It is a strictly annual species and bears only a superficial resemblance to *P. annua*. The chromosome number : 2n = 14. The panicle is oblong in shape, and the branches either ascending or approximately horizontal with spikelets loosely scattered along them. All lemmatal nerves are hairy, but there is no wool at the base of the lemma. The anthers are tiny, being only 0·2–0·3 mm. long. As in *P. annua* Linn. the apical floret is female while all those below it are hermaphrodite. One of the remarkable features of the plant is the thinness of the leaves which are almost translucent.

The identity of *Catabrosa thomsoni* Hook. f. with this plant was quite unexpected and only came to light when the Indian species of *Colpodium* were being studied. The type sheet is at Kew and although the material is meagre and well glued down on the sheet, there is no doubt that the plant represented is *Poa infirma* H.B.K.

Tutin (1952) succeeded in crossing *P. annua* and *P. infirma*, pollen from the latter being used. The hybrid is completely sterile and has 2n = 21, as was to be expected.

Tutin points out that at meiosis seven univalents and seven bivalents are present, and concludes that this condition could only occur if *P. infirma* were one of the parents of *P. annua*. So far no one has demonstrated by an actual cross that *P. infirma* and *P. supina* are the parents of *P. annua.*

3. **Poa nepalensis** Wallich *ex* Duthie, Grasses of North-western India, 40 (1883).

P. annua Linn., var. *nepalensis* Griseb. in Goett. Nachr., 75 (1868).

A tall perennial grass from a creeping rootstock which gives off numerous rootlets from the nodes. *Culms* up to 50 cm. tall, erect, smooth and glabrous, terete, long exserted from the uppermost leaf-sheath, 2–3-noded, geniculate at the base. *Leaf-blades* up to 15 cm. long, 4 mm. wide, linear, tapering to a sharp point, flat, flaccid, shorter or longer than the supporting sheath, scabrid on both surfaces and along the margins. *Sheaths* rather loose, smooth and glabrous, eventually slipping from the culm. *Ligule* membranous, not more than 1·5 mm. long.

Inflorescence a large, pyramidal panicle up to 14 cm. long by 10 cm. wide; central rhachis smooth and glabrous; branches in pairs (one of a pair much shorter than the other), smooth and glabrous, almost capillary, bare at the base for one-third to one-half their total length, shortly rebranched into 2 or 3 arms which occasionally are shortly branched. *Spikelets* whitish in colour, about 4-flowered, 3·5–4 mm. long, elliptic-acute when young, with spreading florets at anthesis. *Lower glume* 1·5–2 mm. long. 0·6 mm. wide, pale in colour, curved on the back, 1-nerved, hyaline on the margins, smooth and glabrous, apart from the

rough upper part of the keel. *Upper glume* 2·25–2·5 mm. long, 1·4 mm. wide, broadly elliptic-acute or elliptic-ovate-acute in shape when flattened, 3-nerved, curved on the back, pale glaucous in colour, hyaline on the margins, scabrid on the upper half of the keel. *Lemma* 2·5 mm. long, 2

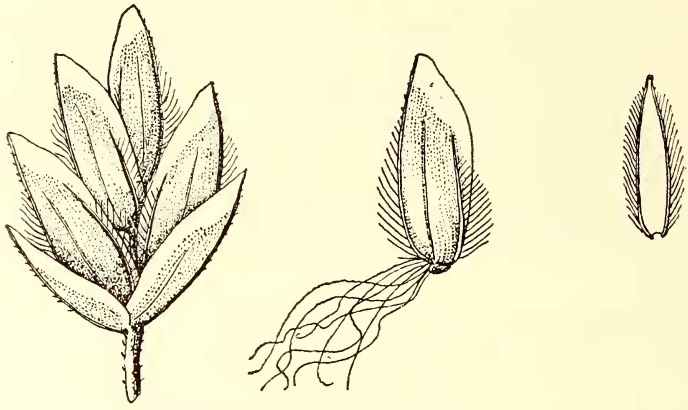


Fig. 3. *Poa nepalensis* Wall., × 10

mm. wide, oblong-elliptic-obtuse in shape, very narrowly hyaline on the margins and at the tip, 5-nerved with inconspicuous intermediate nerves, profusely ciliate on the lateral nerves and on the lower two-thirds of the keel, glabrous in between, very faintly punctate all over the dorsal surface, minutely scaberulous in the lower third. Rhachilla smooth and glabrous. *Wool* copious. *Anthers* linear 0·75 mm. *Palea* shorter than the lemma, broadly oblong-elliptic, long ciliate on the keel to within one-eighth of the apex.

Ind. Or.: Kumaon, Binsar, 2,300 m., *Strachey et Winterbottom* (Type); Tehri Garhwal, Thadiar, 1,000 m., May 1893, *Gamble* 24194; Kulu, Manali, 2,700 m., 9 May 1941, *N. L. Bor* 14101; Dalhousie, 29 Sept. 1874, *C. B. Clarke* 23275c.

The name *Poa nepalensis* Wall. first appears in Duthie's Grasses of North-western India, 40 (1883) where the specimens cited are those of T. Thomson from N.W. India and Strachey and Winterbottom's sheet; from Binsar in Kumaon. In the Flora of British India, Hooker returns to the name *Poa annua* L. var. *nepalensis* which had been given to it by Grisebach in Goett Nachr., N. 3, 75 (1868) who based the variety on two sheets, viz. Strachey's from Kumaon and Hooker's from the Eastern Himalaya. In point of fact all these sheets represent the same species and Strachey and Winterbottom's is selected as the type.

In the Flora of British India, Stapf who worked out this genus introduced another complication, for this species is again reduced to the status of a variety of *Poa annua* but the specimens upon which it is based were altered to *P. annua* β Nees in Herb. Royle and *Poa* Wall. Cat. No. 3791. Royle's specimen is *P. nepalensis* but Wallich's No. 3791 does not fit the description given by Stapf and actually is a different species.

Poa nephelophila Bor

Poa annua Linn.

According to Stapf the characteristics of *P. annua* var. *nepalensis* were, among others, that the keel and outer nerves of the lemma were silky and the wool copious. In Wallich's No. 3791 the lemma is almost glabrous and the wool non-existent. In fact Wallich's 3791 does not conform to the description and, moreover, it is not identical with Strachey and Winterbottom's specimen, nor is it the other specimen to which Duthie refers, namely T. Thomson's specimen. It is therefore quite clear that Wallich No. 3791 must be excluded from consideration. It really is quite a different species, namely, *P. sikkimensis* Bor.

4. **Poa nephelophila** Bor, in Kew Bull. 1948: 139 (1948).

A very leafy, stout, lax, annual grass. *Culms* up to 45 cm. tall, by 1·5 mm. in diameter just below the panicle, to 3 mm. at the base, very smooth and glabrous, erect or slightly geniculate below, clothed at the base with disintegrating old sheaths; nodes smooth and glabrous, visible because of the loose sheaths. *Leaf-blades* green, lax and flaccid, flat, 16 cm. long by 5 mm. broad, linear in shape, tapering gradually to a sharp point, narrowly cartilaginous on the margins which are armed with widely spaced, forwardly pointing teeth, scabrid at the tip on margins and surfaces, very minutely scabrid on the upper surface, often with a few hairs on the margin at the rounded base. *Sheaths* very lax and loose, slipping from the culm and exposing the nodes, smooth and glabrous, minutely striate, the lower falling away completely and surrounding the base of the culm, the upper more or less clasping the stem, shorter than their leaves. *Ligules* short, membranous, erose, not more than 1·5 mm. long.

Panicle pyramidal, up to 12 cm. long, 9 cm. broad; axis stout to capillary, smooth and glabrous, nodes up to 3·5 cm. apart; branches whorled in 4's, smooth and glabrous, up to 3·5 cm. long before branching; branchlets scaberulous, sparsely rebranching and carrying a few crowded spikelets. *Spikelets* narrowly oblong in shape, 5–6·5 mm. long, 4–6-flowered, pale green. *Lower glume* 2–2·5 mm. long, 0·8 mm. broad, 1-nerved, oblong- or lanceolate-acuminate when flattened, curved on the keel, narrowly hyaline along the margins in a definite band; smooth and glabrous except the keel which is most minutely scabrid along the whole length. *Upper glume* 2·5–3 mm. long, 1·5 mm. broad, curved on the back, elliptic-acuminate in shape when flattened, hyaline in a definite narrow band on the margins, 3-nerved, smooth and glabrous except for the keel which is minutely scabrid. *Lowest lemma* 3·5 mm. long, 2 mm. wide when flat, oblong-obtuse in shape when flattened, distinctly 5-nerved, very shortly hyaline at the tip and along the margins, ciliate on the keel in the lower two-thirds, scabrid on the keel above, ciliate on the lateral nerves, not ciliate on the intermediate nerves. *Wool* practically absent. *Rhachilla* long jointed; joints 0·75 to 1 mm. long, glabrous. *Anthers* minute, 0·6–0·75 mm. long. *Palea* shorter than the lemma, ciliate on the keels.

Burma: Chimli Pass, 3,300 m., 11 May 1929, *Sukoe* 9974 (Type).

A very leafy species with a large panicle the branches of which are 4-nate.

Very close to *P. annua* Linn., but it has a very different appearance—the spikelets are slightly larger, the panicle branches are in whorls of four and the intermediate nerves of the lemma are glabrous.

5. **Poa supina** Schrad., Flor. Germ. 1: 289 (1806).

A perennial grass, sending out leafy runners above ground. *Culms* up to 25 cm. tall, usually not much more than 15 cm., usually decumbent at the base, clothed with leaves almost to the tip and with old sheaths in the lower part. *Leaf-blades* linear and contracted suddenly to a rather stout tip, 1–2·5 cm. long, 2–3 mm. wide, dark green, flaccid, more usually flat, sometimes folded, scabrid along the margins, especially towards the rather short tip; those of the sterile shoots much longer up to 6 or 7 cm., and correspondingly broad. *Sheaths* at the base much longer than the internodes, very loose, scarious, smooth and glabrous, shining, hyaline on the margins, those of the culm much tighter, clasping, striate, smooth and glabrous, hyaline on the external margin. *Ligule* membranous up to 1·5 mm. long, rounded at the tip.

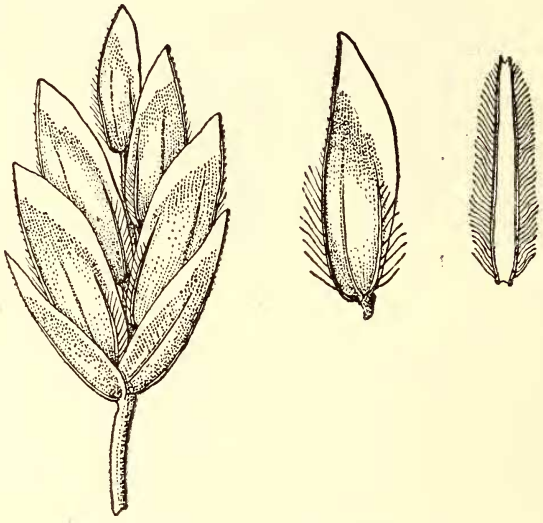


Fig. 4. *Poa supina* Schrad., × 10

Inflorescence, at first a dense, pyramidal, usually purplish panicle, usually as long as broad, afterwards spreading and finally with deflexed branches; axis smooth and glabrous; branches in pairs or often single, the single branch soon dividing into two equal branchlets which rebranch, smooth and glabrous. *Spikelets* 5–6-flowered, 4–5 mm. long, clustered at the ends of thin branchlets. *Lower glume* 1·5 mm. long. 0·8 mm. wide, oblong-acute in shape when flattened, slightly curved on the back, 1-nerved, hyaline at the tip and narrowly along the margins, smooth and glabrous, suffused with purple. *Upper glume* 2·5 mm. long, 1·2–1·3 mm. wide, elliptic-acute or elliptic-obovate-acute in shape, suffused with purple, 3-nerved, narrowly to broadly hyaline on the margin, hardly hyaline at the tip, minutely scabrid on the keel. *Lemma* 2·5–3–3·5 mm. long, 2–3 mm. wide, herbaceous, broadly elliptic-obtuse or oblong-ovate-obtuse in shape when flattened, 5-nerved, very hyaline at the tip and hardly hyaline along the margins, prominently 5-nerved, ciliate on the keel in the lower half or two-thirds, scabrid on the keel above, ciliate on the marginal nerve, otherwise smooth and glabrous.

Rhachilla smooth and glabrous, produced beyond the topmost floret and carrying a rudimentary floret. *Wool* absent. *Anthers* 1·2–2 mm. long. Upper floret several times longer than the rhachilla joint. *Palea* shorter than the lemma, ciliate on the keels.

Ind. Or.: Himalaya; Tehri Garhwal, 4,000 m., 28 Sept. 1948, *W. Koelz*, 22025; Kashmir, Baltal in Sind Valley, 3-3,700 m., 28 June 1892, *Duthie* 11599 Hazara, Suan Valley, 29 June 1896, *Mayat* 20352; Gulmarg, 2,700-3,000 m., 26 June 1893, *Duthie* 13032; Lahul, above Kandang, 6 July. 1888, *Drummond* 23354. Chitral; Barum Gol, Shokor Shal, 3,300 m., 22 June 1950, *Per Wendelbo* s. n., ' by a brooklet'.

This very distinctive grass is found in the Himalaya at altitudes above 2,000 m. only. The panicle is broadly triangular in shape, and the branches, either horizontal or deflexed, with the spikelets crowded at the tips of the branches, give a facies which is quite different from that of *P. annua*. The intermediate lateral nerves of the lemma are glabrous. There is no wool at the base of the lemma. The anthers are larger (often 3 times as large) than those in *P. annua*, being 1·6–2 (2·5) mm. long. The keels of the palea are long ciliate. This is always a perennial grass. The chromosome number of *P. supina* Schrad. is 2n = 14 (Nannfeldt 1935). The apical floret in the spikelet is female, while all the others are hermaphrodite.

6. **Poa annua** Linn., Sp. Pl. ed. 1, 68 (1753).

P. royleana Steud., Syn. Pl. Glum. 256 (1854).

An annual, sometimes biennial or exceptionally a perennial, grass. *Culms* erect or more often geniculate, ascending from a fibrous root-stock, up to 30 cm. tall, usually much shorter. Runners often rooting at the nodes, forming buds in the axils of the sheaths which immediately develop, and after bursting through the sheaths send out other runners and vertical stems which flower. *Leaf-blades* usually 2–3·5 cm. long, but often very much longer in favourable habitats up to 5 mm. wide, linear, suddenly contracted to a stout tip, flat, flaccid, dark green, scaberulous on the margins. *Sheaths* somewhat compressed, smooth and glabrous, covering the nodes or not. *Ligule* of the upper leaves up to 3 mm. long, of the lower much less, often only 1·5 mm. long.

Inflorescence a loose pyramidal panicle, often one-sided, 1·2–1·6 times as long as broad; branches 2-(rarely 3–5-)nate or solitary, spreading, eventually almost deflexed, 2–8 mm. long before branching, smooth and glabrous. *Spikelets* more or less crowded, seated on scabrid pedicels, 3–5-flowered, ovate or elliptic-oblong in shape, 4–6 mm. long, green, sometimes tinged with violet. *Lower glume* 1·5–2 mm. long, 1 mm. wide, lanceolate-acute or -acuminate in shape, 1–nerved, hyaline on the margins, scabrid on the keel. *Upper glume* 2–2·5 mm. long, 1·5 mm. wide, elliptic-acute when flattened, 3–nerved, with a conspicuous hyaline or whitish band all along the margin, scabrid on the keel. *Lemma* 3 mm. long, 1·5 mm. wide, oblong-obtuse, herbaceous in texture with a broad hyaline or whitish band all along the margins, 5 -nerved, silky ciliate on the keel for three-quarters of its length, cilliate on the lateral nerves below, for the rest smooth and glabrous. Lowest floret hermaphrodite, the upper 1 or 2 female, the topmost seated on a

rhachilla section, about one-half as long as the floret. *Wool* absent. *Rhachilla* smooth and glabrous, produced beyond the topmost floret and crowned with a rudimentary floret. *Anthers* 0·6–0·8 mm. long, yellow. *Palea* elliptic-truncate, long ciliate on the keels, but occasionally almost glabrous though usually some hairs will be discovered.

This cosmopolitan grass is found everywhere in India and Burma above the 1,300 m. contour. Sir Joseph Hooker collected it on Wallanchoon Pass in Sikkim at 4,000 m. altitude, and it is probably found at even greater heights in shaded places. A specimen has recently been collected in Delhi. This was sent to Kew by Shri M. B. Raizada, Forest Botanist, Forest Research Institute, Dehra Dun, with the observation that it is to be found in Delhi in cool shady places in winter. Actually there is no reason why *Poa annua* should not flourish in the cold season in Delhi where the temperatures, at least at night, in the winter are very low. The extensive irrigation system in the plains would facilitate the transport of seed from the hills.

This species is usually found as an annual, though it is sometimes a biennial, rarely perennial. In England the flowering period is often prolonged and sometimes starts as early as December. The hairiness of the lemmatal nerves is variable but all of them are more or less hairy. The anthers are medium sized, 0·6–0·8 mm. long. Wool at the base of the lemma is absent. The keels of the palea are covered from the base up to the tip with long cilia, but in some races the hairs are much reduced in number or almost entirely absent.

The chromosome number is 2n = 28 and frequent hybrids between it and *Poa supina* Schrad. have been obtained in Sweden (Nannfeldt 1935), suggesting that it hybridises freely in nature. The chromosome number of the hybrid is 2n = 21. According to Hackel the apical floret is ordinarily earlier in opening than the lower florets. This is contrary to the normal sequence of flowering in grasses. Moreover, this floret is female in sex but all those below it are hermaphrodite. This is a characteristic of the closely allied species *P. supina* Schrad. and *P. infirma* H.B.K.

Nannfeldt (1937) has speculated concerning the origin of *Poa annua* Linn. He points out that on morphological grounds alone the probability that *Poa annua* Linn. is an allotetraploid and is the result of a cross between *P. supina* Schrad. and *P. infirma* H.B.K. is very strong, since the morphological characters of *P. annua* are intermediate in every particular between those of the other two. Moreover it shows all the characteristics of hybrids, not only in hybrid vigour, but in its great adaptability to varying ecological conditions. At the present time it is one of the most cosmopolitan of grasses, and shows all intermediates between strictly annual plants and subperennials. Further evidence that Nannfeldt's hypothesis may be correct is deduced by Tutin (1952) who succeeded in pollinating *P. annua* with pollen from *P. infirma*. The hybrid is sterile and has 2n = 21. At meiosis it has seven bivalents and 7 univalents, a condition which could only arise if *P. infirma* were in effect a parent of *P. annua*.

7. **Poa sikkimensis** Bor, in Kew Bull. 1952: 130 (1952).

P. annua Linn. var. *sikkimensis* Stapf in Hook. f., Flor. Brit. Ind. 7: 346 (1896).

An annual or subperennial grass. *Culms* up to 30 cm. tall, usually geniculate at the base, with many fibrous roots, covered at the base with the scarious remains of old sheaths, smooth and glabrous, covered with leaves almost to the panicle, terete. *Leaf-blades* flat, linear, tapering to a blunt point, suddenly contracted at the base to the sheath, smooth and glabrous on both surfaces, or minutely to strongly scabrid at the tip, margins usually scabrid, sometimes smooth, up to 10 cm. long, 5 mm. wide, flaccid, green. *Sheaths* rather loose below, tight above. *Ligule* long, membranous, smooth, 3–6 mm. long, erose at the top.

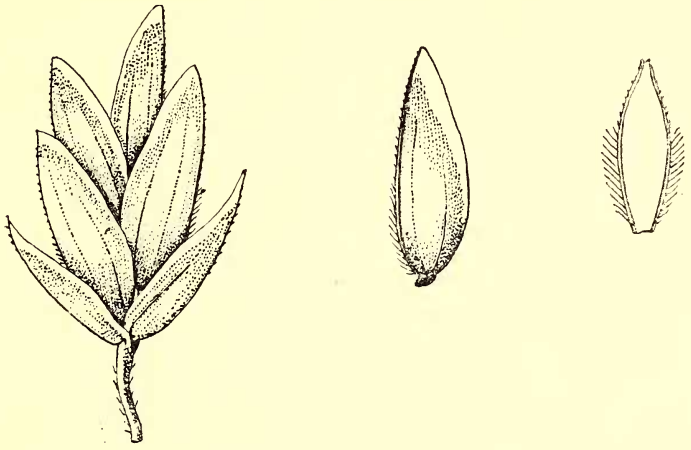


Fig. 5. *Poa sikkimensis* Bor, × 10

Inflorescence a panicle up to 15 cm. long, pyramidal or oblong in shape; axis smooth and glabrous; nodes often wide apart, the length of the lowest internode may be 4 cm.; branches binate, flexuous, capillary, ascending divergent or even deflexed; branchlets nearly always scaberulous. *Spikelets* oblong in shape, up to 4 mm. long, 3–4-flowered; pedicels short, scabrid. *Lower glume* 1·5–2 mm. long, 0·8 mm. wide, mostly 3-nerved, rarely 1- or 2-nerved, sometimes indistinctly, hardly hyaline on the margins, lanceolate- or oblong- or narrowly elliptic-acute when flat, suffused with purple. *Upper glume* 2·5–2·75 mm. long, 1·5 mm. wide, broadly elliptic-obovate-acute when flattened, 3-nerved, denticulate on the margins, scabrid on the upper half of the keel, hardly hyaline on the margins, smooth and glabrous. *Lemma* 2·75–3 mm. long, 2 mm. wide, broadly elliptic-obovate-obtuse when flat, somewhat firmly chartaceous, narrowly hyaline all along the margins to the top, rather faintly 5-nerved, shortly ciliate on the keel in the lower half, scabrid on the keel above, glabrous on the intermediate nerves, glabrous or ciliate on the lateral, smooth and glabrous over the dorsal surface which is very finely gland-pitted, often with a narrow band of yellow below the hyaline tip succeeded by violet. *Wool* completely absent. *Rhachilla* smooth and glabrous, produced beyond the uppermost floret and carrying a rudimentary floret. *Anthers* 0·5–0·8 mm. long. *Palea* scabrid on the keel in upper third, ciliate below.

Ind. Or.: Sikkim, Wallanchoon, 3–4,000 m., *J. D. Hooker* (Type); North-east Sikkim, 1893 *Cummins*; Lachung 3,500--4,000 m., 30 Aug. 1849, *J. D. Hooker*; Morray Samdang, 2 Sept. 1849, *J. D. Hooker*; Phusum, 3,000 m., *Bor et Kiratram* 19936.

This species was treated in the Flora of British India as a variety of *Poa annua* L. with which it has little in common. It can easily be distinguished from *P. annua* by the 3-nerved lower glumes, firmly chartaceous lemmas which are broader and by the palea which is ciliate on the keels below but scabrid in the upper third. The anthers are 0·5–0·8 mm. long. The panicle-branches at maturity are often reflexed.

8. **Poa stapfiana** Bor, in Kew Bull. **1949**: 239 (1949).

P. tremula Stapf in Hook. f., Flor. Brit. Ind. **7**: 344 (1896) non Lam.

A perennial, stoloniferous grass with leafy culms and fibrous roots. *Culms* up to 60 cm. tall, erect or geniculate at the base rooting at the basal nodes, 5-6-noded, the lower close, the upper widely separated, terete, smooth and glabrous, striate. *Leaf-blades* 5–14 cm. long by 1–5 mm. wide, at the top often much less, tapering gradually or abruptly to a sharp point; flaccid or occasionally firm, the upper as long as or longer than the subtending sheath, glabrous, distinctly toothed on the cartilaginous margins, smooth or minutely scabrid on the upper surface. *Sheaths* covering the nodes, rather loose, smooth and glabrous, scarious below, striate, the lower slipping from the internodes and disintegrating into pale yellow fibrous threads; the shape of the line of junction of leaf and sheath is an inverted U. *Ligule* up to 5 mm. long, hyaline, rounded.

Fig. 6. *Poa stapfiana* Bor, × 10

Inflorescence a lax, loose, widely spreading, pyramidal panicle up to 25 cm. long; axis smooth and glabrous, stout at the base, filiform at the tip; branches long and flexuous, lowest binate, very rarely 1- or

3-nate, up to 15 cm. long, smooth or nearly so, glabrous, capillary, loosely branched towards their tips; branchlets rough, glabrous, carrying a few short pedicelled spikelets. *Spikelets* elliptic-oblong, 4–6 mm. long, 3–5–6-flowered, crowded at the tip of the branches, green or somewhat glaucous in colour. *Lower glume* rather variable in length, 2·75–3·75 mm. long, 1–1·5 mm. wide, oblong-lanceolate, elliptic-oblong or even lanceolate-acute or acuminate, gently curved on the back, normally definitely 3-nerved but 1-nerved lower glumes are often found, hyaline at the tip and narrowly so along the margins, glabrous, coarsely scabrid on the keel in the upper half, and on the terminal portion of the lateral nerves. *Upper glume* 3–4·5 mm. long, 1·5–1·75 mm. wide, oblong-, elliptic- or even oblanceolate-acute or -acuminate, slightly curved on the back when seen in profile, glabrous, 3-nerved, coarsely scabrid on the keel in the upper half and occasionally on the side nerves. *Lowest lemma* 3–4·5 mm. long, sometimes, though rarely, suffused with purple, with a yellow streak at the tip just below the hyaline portion which is very definite and may extend to one-eighth of the length of the lemma, oblong-obtuse when flattened, erose at the tip, dorsal surface glandular-punctate, ciliate on the keel to the middle and scabrid above, ciliate on the lateral nerves, with many or few silky hairs on the dorsal surface in the lower half; succeeding lemmas similar, diminishing in size. *Wool* definite, copious or scanty. *Rhachilla* hairy, produced beyond the uppermost fertile floret and surmounted by a rudimentary floret. *Anthers* 1–1·5 mm. long. *Lodicules* 2, very small, unequally 2-fid, sometimes up to 1·5 mm. long. *Palea* 2·5 mm. long, 6 mm. wide, lanceolate-oblong in shape; keels rather long ciliate in the lower half, covered in the upper half with prickles diminishing in length from below upwards and finally reduced to short antrorse teeth, occasionally lower half with longer teeth than those in the upper half and not definitely semi-pilose.

Ind. Or.: West Himalaya; Boope Valley, *Jacquemont* 277; Dharamsala, Laka, 3,700 m., *C. B. Clarke* 24414; Nepalia, *Wallich* 3798; Kashmir, Upper Sind Valley, 28 Sept. 1848, *T. Thomson*; Ladak, Leh, 4,000 m., 1856, *Schlagintweit*; Manali, 2 Aug. 1941, 3,700 m., *N. L. Bor* 15575.

The long panicle branches bare at the base and the silky lemmas are very characteristic of this species.

var. **micranthera** Bor, comb. nov. *P. tremula* var. *micranthera* Stapf.

The variety is typical *P. stapfiana* Bor except for the very minute anthers. Since variability in the length of the anthers is a very rare phenomenon in the Himalayan *Poae*, none in the present review apart from this variety having been found, a special study of the variety was made in order to find out whether characters specifically different from the type exist. As already stated, however, it is not possible to separate the variety on any character except the size of the anthers.

Ind. Or.: Kashmir, Palgam, 4 Sept. 1876, 3,900 m., *C. B. Clarke* 31057; Pahlgam, 4 Sept. 1876, 4,000 m., *idem* 31061; Tilail, 23 Aug. 1876, *idem* 30667.

Lahul, Rotang, 11 July 1941, 4,000 m., *N. L. Bor* 9806.

II. Himalayenses

9. **Poa himalayana** Nees *ex* Steud., Syn. Pl. Glum. 256 (1854).

A tufted grass, slender when annual, stouter when perennial. The perennial has a slender rhizome. *Culms* very smooth and glabrous, terete, 0·5–1 mm. in diameter below the panicle. *Leaf blades* linear, up to 15 cm. long, 2 mm. wide, scabrid on both surfaces, becoming smooth with age, very scabrid on the margins, often hairy on the rounded base where the blade joins the sheath, flat, flaccid, glabrous. *Sheaths* tightly fitting, old often loose, scarious, slipping from the culm, smooth and glabrous, not covering the nodes. *Ligule* up to 2 mm. long, often rough or hairy on the outside.

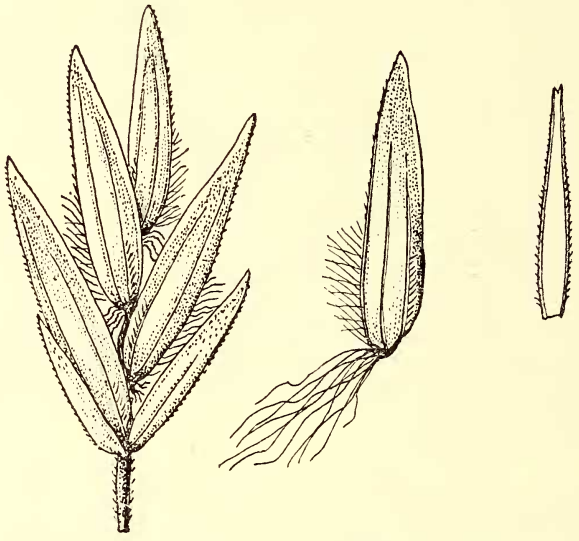


Fig. 7. *Poa himalayana* Nees, × 10

Inflorescence a panicle, often lax, with widely spreading branches, up to 16 cm. long, 8 cm. broad; rhachis of the panicle glabrous and smooth; branches in twos, up to 3 cm. without branching, scabrid; branchlets scabrid, sparsely rebranching. *Spikelets* narrowly oblong, 4·5–6 mm. long, 3-flowered, occasionally only 1-flowered. *Lower glume* 2·25–2·5 mm. long, 0·5 mm. wide, awl-shaped in profile, lanceolate-acuminate in shape when flattened, 1-nerved, slightly curved on the back, scabrid on the keel and on the dorsal surface near the tip, very narrowly hyaline on the margins. *Upper glume* 2·75–3·5 mm. long, 1 mm. wide, lanceolate- or narrowly ovate-acute in shape when flattened, 3-nerved, scabrid on the keel and side nerves especially towards the tip, very narrowly hyaline on the margins. *Lemma* 4–4·5 mm. long, 1·5 mm. wide, conspicuously 5-nerved with nerves reaching nearly to the margin, long-ciliate on the lower half of the keel, scabrid above, shortly ciliate in the lower portion of the lateral nerves, very narrowly hyaline along the margins and at the tip or not hyaline at the tip, very glabrous between the lateral nerve and keel, but dorsal surface finely pitted or surface

scaberulous. *Wool* present, often fairly copious. *Rhachilla* joints long up to 1·5 mm. long, continued as a slender stipe up to 2 mm. long, crowned with a rudimentary spikelet. *Anthers* 0·75–1 mm. long. *Palea* 3 mm. long, narrowly elliptic in shape, armed on the keels with very fine antrorse teeth.

Ind. Or.: Nepalia: 1821, *Wallich* 8885 (Type); Sikkim: Lachen, 3,000 m., 11 June 1849, *J. D. Hooker*; Sandhakphu, 2,600 m., May, 1894, *C. B. Clarke* 35029; Sandhakphu, 4,000 m., July 1881, *Gamble* 9052; Phusum, 3,500 m., 25 June 1945, *Bor et Kiratram* 19915. Tibet: Chubitang, 4,000 m., 22 June 1945, 'in marshes in fir forest', *Bor et Kiratram* 19647.

This is one of the commonest grasses in Sikkim above 3,000 m., but it has been much confused in the past. The description of it given by Hook. f. in the Flora of British India is quite misleading, for it is based in part upon a closely related, but quite distinct, species, namely, *P. stewartiana* Bor. For a discussion upon the differences between these two species the reader is referred to *Kew Bulletin*, 1951, 181.

10. **Poa stewartiana** Bor, in Kew Bull. **1951**: 185 (1951).

A delicate annual grass. *Culms* very slender, smooth and glabrous, somewhat striate, glabrous at the nodes. *Leaf-blades* linear-acuminate, green, flaccid, rounded at the base to the sheath, flat, minutely scabrid on the margins, especially towards the stout tip, smooth and glabrous on both surfaces, up to 15 cm. long, 3–4 mm. broad, uppermost leaves as long as or shorter than the subtending sheath. *Sheaths* tight, smooth and glabrous, striate, longer than the internodes. *Ligules* milky, membranous, 2·5–3 mm. long.

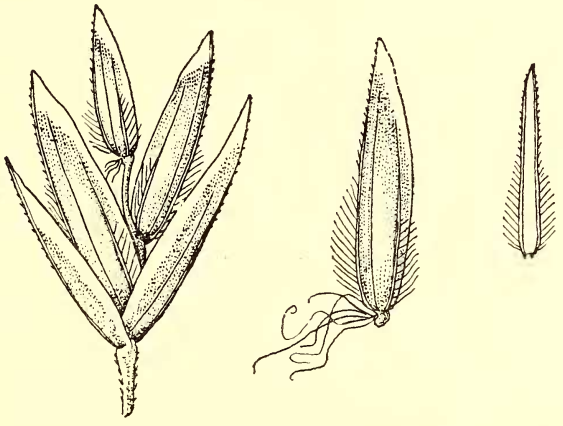


Fig. 8. *Poa stewartiana* Bor, × 10

Inflorescence a weakly spreading, often nodding panicle up to 20 cm. long, 10 cm. broad or even larger; axis angled, capillary, very minutely scabrid or scaberulous or even smooth, striate; branches in pairs, erect, spreading or finally deflexed, flexuous, scaberulous, bare for 3–4 cm. and then rebranching and carrying a few spikelets at the tips. *Spikelets*

3–5 mm. long, broadly elliptic when young, wedge-shaped when old, 3–4-flowered. *Lower glume* 2·5–3 mm. long, 0·75–1 mm. wide at the widest parts, lanceolate-acuminate in shape when flattened, awl-shaped in profile, curved on the back, 1-nerved, smooth and glabrous except on the keel in the upper half which is scabrid. *Upper glume* 2·5–4 mm. long, 1–2 mm. wide, oblong-acute or oblong-elliptic-acute, 3-nerved, straight on the back in profile in the lower two-thirds then gently curving towards the tip, hyaline on the margins, smooth and glabrous, except for the scabrid upper half to the keel. *Lemma* 2·5–3·5 mm. long, 1·75–2 mm. wide, oblong-elliptic-acute, 5-nerved, smooth and glabrous on the dorsal surface, ciliate on the keel in the lower half and on the marginal nerves or the latter glabrescent, hyaline on the margins, coarsely scabrid on the keel in the upper half. *Rhachilla* smooth. *Wool* copious. *Stamens* 3. *Anthers* yellow, 1 mm. long. *Palea* shorter than the lemma, strongly 2-keeled, ciliate on the keels in the lower half, scabrid above.

Ind. Or.: N. W. India; Jaunsar, 2,000 m., 5 May 1897, *Duthie* 19777, 'in forest' (Type); wet rocks on old Mahasu road, 2,300 m., 25 June 1878, *J.S. Gamble* 6,237A; Bussahir-Kunawar, 1885, *J. F. Duthie*. Kashmir, Tragbol, 3,200 m., 19 July 1876, *C. B. Clarke* 29244; Gulmarg, 3,000 m., July 1926, *R. R. Stewart* 8675. Near Simla, June 1889, *J. F. Duthie* 10137; Simla 27 Aug. 1849, *T. Thomson*; Punjab, *J. R. Drummond* 21362.

For a discussion regarding the merits of this species vis-à-vis its closest relative *P. himalayana* Nees, the reader is referred to *Kew Bulletin* 1951, 181.

11. **Poa khasiana** Stapf, in Hook f., Flor. Brit. Ind. 7: 343 (1896).

A tall, slender, loosely tufted, perennial grass without rhizomes. *Culms* up to 70 cm. tall, smooth, terete, erect or somewhat geniculate at the base, rooting at the nodes, clothed at the base with a few loose, scarious, membranous sheaths. *Leaf-blades* linear, tapering to a rather sharp point, up to 20 cm. long by 3 mm. wide, flat, flaccid, or the shorter ones rigid, minutely scabrid on the upper surface, smooth below, glabrous, smooth on the margins, becoming very scabrid towards and at the tip; midrib and lateral nerves strongly marked. *Sheaths* smooth and glabrous, rather loose on the culm, very loose at the base, longer or shorter than the leaf. *Ligule* very short, not more than 1 mm. long, erose.

Inflorescence a pyramidal panicle with horizontal branches and few spikelets, nodding when young, rather contracted, branches subsequently spreading or standing at right angles to the stem; lower branches 3–5-nate, scaberulous to the base, branched; branchlets very short, scaberulous, carrying only a few spikelets, often only one; axis smooth and glabrous below, scaberulous above. *Spikelets* usually 3-flowered, oblong-elliptic in shape when young, wedge-shaped at anthesis. *Lower glume* 2–2·5 mm. long, 1 mm. broad, slightly curved on the back, lanceolate-narrowly-elliptic or oblong-acute in shape, glabrous, sparsely gland-dotted on the dorsal surface, 1-nerved, narrowly hyaline on the margins, minutely rough on the keel in the upper half. *Upper glume* 3–3·5 mm. long, 1·5 mm. wide, elliptic-acute or oblong-ovate-acute

when flattened, 3-nerved, slightly curved on the back, glabrous, coarsely scabrid on the keel in the upper half, on the dorsal surface in the upper quarter and on the side nerves. *Lemma* 3–4 mm. long, 1·5 mm. wide, oblong-obtuse in shape, conspicuously 5-nerved, side nerves

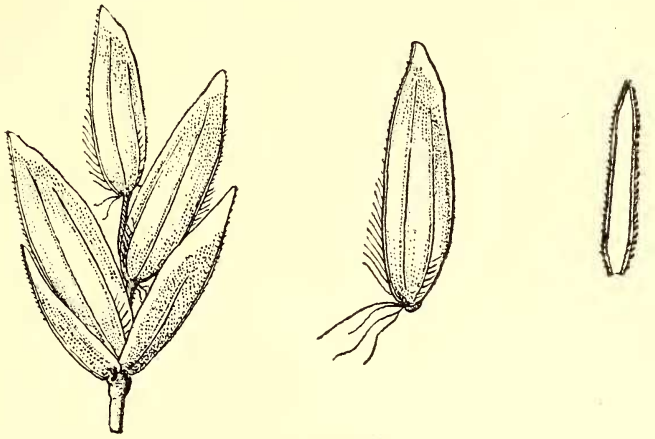


Fig. 9. *Poa khasiana* Stapf, × 10

running almost to the top which is very shortly hyaline, narrowly hyaline on the margins which are distantly toothed, whole of the dorsal surface glandular-punctate, ciliate on the keel in the lower half, scabrid in the upper half, ciliate on the marginal nerves, on the whole of the dorsal surface almost glabrous, occasionally with the most minute scabridities in the lower half of the dorsal surface. *Wool* absent or scanty. *Rhachilla* with 3 joints; in a typical instance, 1, 1·25–1·5 mm. in length, the uppermost slender and carrying a rudimentary spikelet, rather warty. *Anthers* 1 mm. long or just under. *Lodicules* 1-toothed. *Palea* 2·75–3·75 mm. long, scabrid on the keels.

Ind. Or.: Khasi Hills; Cherrapunji, 2,000 m., 18 June 1850, *J. D. Hooker* (Type); Shillong, 1,500 m., 17 April 1886, *C. B. Clarke* 43383; Maflang 1,500 m., 2 July 1850, *J. D Hooker*; Shillong, 2,000 m., 2 May 1943, *N. L. Bor* 17392.
Naga Hills; Thekubnma 2,300 m., 18 June 1935, *N.L. Bor* 4460.

This grass bears some resemblance to *Poa pratensis* Linn., particularly in those specimens which have connecting wool. There are, however, no rhizomes, the lowest branches are 2-nate not 5-nate, and the lemmas are smoother and more glabrous. The amount of wool is variable and occasionally almost absent. It is a much more robust plant than *Poa himalayana* Nees, which it also resembles. If a spikelet of each be examined, however, it will be found that the tip of the lower glume in *P. himalayana* does not exceed the mid-point on the keel of the lowest lemma. In *P. khasiana* the tip of the lower glume does overlap the mid-point of the lemma. Moreover, the lemmas in *P. khasiana* are shorter than those in *P. himalayana* and give the spikelet a different appearance.

This species is found inside forests and along forest margins and in moist shady places generally.

12. **Poa wardiana** Bor, in Kew Bull. 1948: 143 (1948).

A slender grass, probably perennial. *Culms* up to 35 cm. tall, straight, rather weak, somewhat decumbent at the base, scabrid below the panicle, smooth and glabrous elsewhere; internodes longer than the sheaths; nodes smooth and glabrous. *Leaf-blades* up to 8 cm. long, 2 mm. wide, soft and flaccid, green, minutely scabrid above and below and on the margins, linear, abruptly contracted to the hooded tip, shorter than the subtending sheath. *Sheaths* rather tight, smooth and glabrous, striate, the old sheaths clothing the base or slipping from the culms. *Ligules* truncate, lacerate, 1·5 mm. long.

Inflorescence a rather delicate panicle; lower branches long, flexuous, scabrid, bare from 2–3·5 cm., branching; branchlets carrying a few spikelets at the tips. *Spikelets* oblong-elliptic in shape, 4·5 mm. long, 2–3-flowered, the florets diverging at anthesis. *Lower glume* 2·5 mm. long, 0·8 mm. wide, oblong-acute in shape when flattened, rather thin, 1- occasionally 2-nerved, smooth and glabrous, except on the keel which is scabrid, slightly curved on the back, flushed with purple. *Upper glume* 2·5 mm. long, 1·2 mm. wide, ovate lanceolate- or elliptic-acute, slightly curved on the back, 3-nerved, narrowly hyaline on the margins, suffused with purple near the tip and/or along the margins, smooth and glabrous except for the scabrid keel. *Lemma* 3 mm. long, 2·5 mm. wide, broadly oblong-obtuse when flattened, prominently 5-nerved, coarsely scabrid on the dorsal surface as well as on the keel and nerves, otherwise glabrous, hyaline at the tip and along the margins, sparsely ciliate on the keel towards the base. *Wool* absent. *Rhachilla* smooth and glabrous, joints rather long, prolonged beyond the topmost floret and carrying a rudimentary floret. *Stamens* 3; *anthers* 0·75 mm. long, purple. *Palea* of the topmost floret longer than its lemma, it and the others coarsely toothed on the keels, scabrid on the flaps and between the keels.

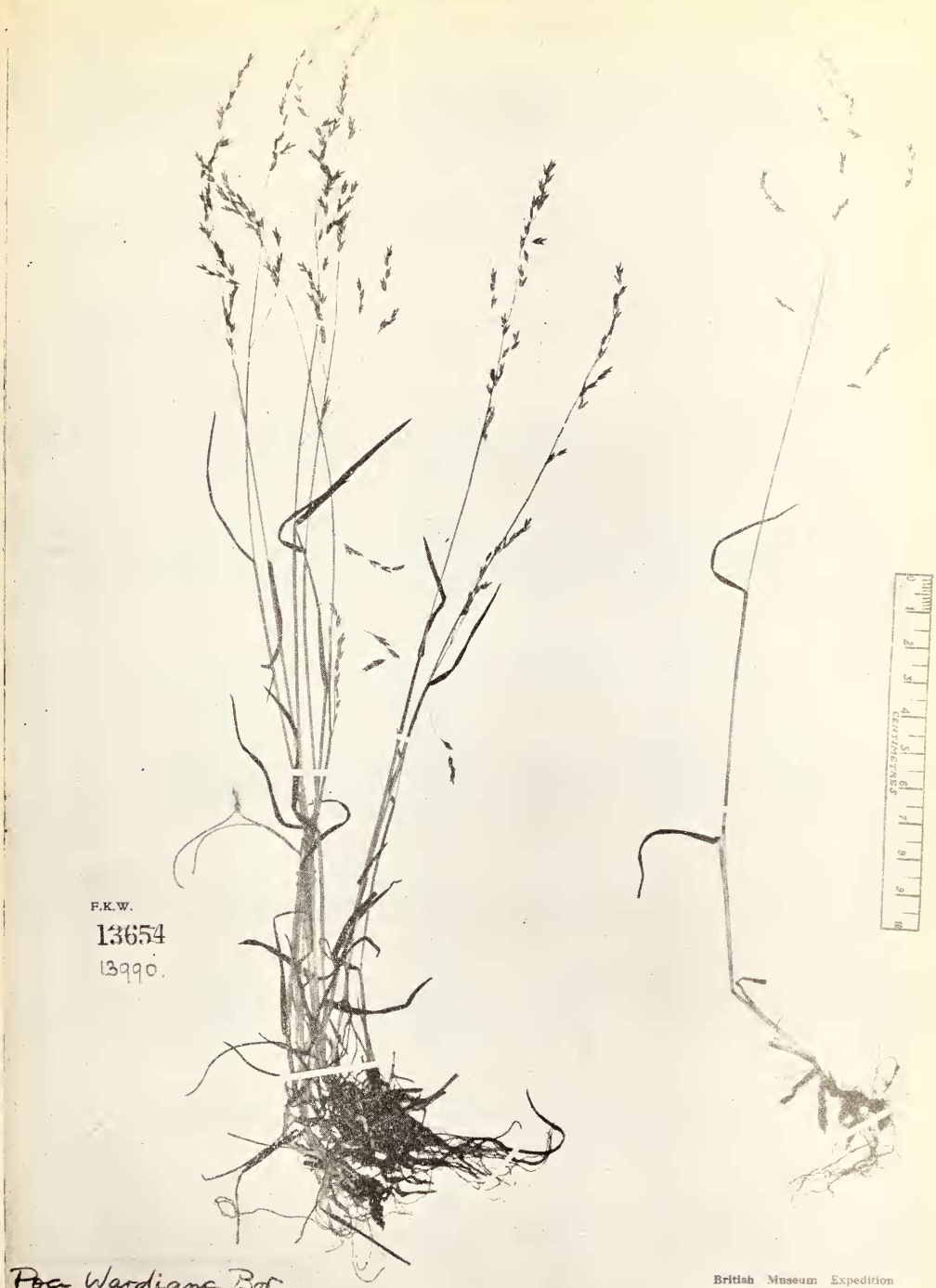
India: Assam, Balipara Frontier Tract, Poshing La 3-4,000 m., 21 July 1938, *Capt. F. Kingdon-Ward* 13990. 'A shade grass scattered along the path in Silver Fir-Rhododendron climax'.

This species is extremely like *P. himalayana* superficially, but can be readily separated from it by the culm being scabrid under the panicle and by the absence of wool at the base of the lemmas. The lemmas themselves, moreover, are very scabrid, as also is the palea on the flaps and between the keels.

III. Nemorales

13. **Poa nemoralis** Linn., Sp. Pl. ed. 1, 69 (1753).

A perennial forest grass with short stolons, reaching a height of 80 cm. and forming loose assemblages. *Culms* usually erect but often rising from a weakly geniculate base, very slender, very smooth, glabrous, terete, rather weak. *Leaf-blades* linear-acuminate, narrow, not more than 2 mm. broad, tapering to an acuminate tip, up to 20 cm. long, but usually much shorter, the topmost not more than 10 cm. long, longer than the subtending sheath, strongly contracted at the base to the sheath, rough on both surfaces and on the margins, rather soft, bright



Poa wardiana Bor

green. *Sheaths* rather tight, but slipping from the culm at the base, smooth and glabrous. *Ligule* often entirely absent, at the most a narrow membranous annular ring, not more than 0·5 mm. wide.

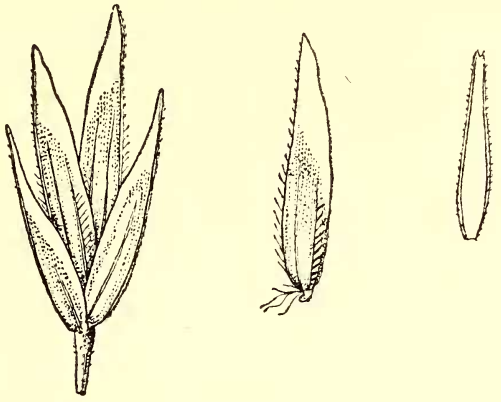


Fig. 10. *Poa nemoralis* Linn., × 10

Inflorescence a very loose panicle not more than 15 cm. long, but usually about 10 cm., with widely spreading branches at flowering time, sometimes nodding ; panicle-branches usually rough, 1–4-nate, loosely branched with branchlets carrying few spikelets up to 4–6 mm. long, narrowly elliptic-acute or lanceolate-acute in shape, green, bright brown or suffused with purple, 2–5-flowered. *Lower glume* 2·5–3 mm. long, 1 mm. wide, lanceolate-acuminate in shape when flattened, awl-shaped in profile, broadly or narrowly hyaline on the margins, 3-nerved, occasionally 1-nerved with a very slender second, slightly curved on the back, smooth and glabrous, apart from the keel which is scabrid. *Upper glume* 3–3·5 mm. long, 1·5 mm. wide, elliptic-lanceolate-acute when flattened, 3-nerved, broadly or narrowly hyaline on the margins, curved and rough on the keel. *Lemma* 3–3·25 mm. long, 1·5 mm. wide, narrowly oblong-acute or sub-obtuse when flattened, 5-nerved, slightly curved on the back, hyaline in its upper quarter and along the margins, ciliate on the keel in the lower half and scabrid in the upper half, ciliate on the marginal nerves, glabrous and smooth in the intervening spaces (or very occasionally puberulous). *Wool* present, often very scanty. *Rhachilla* minutely hairy. *Anthers* 1·2–1·5 mm. long or even a little longer. *Palea* shorter than the lemmas, scabrid on the keels.

Ind. Or.: Kashmir, Burzil Valley, 3,000 m., 18 September 1893, *Duthie* 14067 ; Badarwar Valley, Chenab, 2 June. 1848, *T. Thomson*; Mussoorie, July 1845, *T. Thomson* ; Kumaon, 2,800-3,000 m., 14 July, 1886, *Duthie* 6160; Jaunsar, 2,000 m., June 1892, *Gamble* 23499.

Tibet: Gautsa, 4,200 m., 29 May, *Bor* 19431.

The species which is called *P. nemoralis* Linn. in this revision is that species which I conceive to be true *P. nemoralis* Linn., namely, a species of which the characteristics are a very short ligule, not above 0·5 mm. long, and a lower glume which is 3-nerved, very narrow and acuminate,

almost subulate. In the *Flora of British India* var. *Linnaei* Stapf is what is understood by the above. The erection of var. *ligulata* Stapf to cover species with a ligule up to 3 mm. long, introduced an element which is quite foreign to true *P. nemoralis* Linn. A glance through the folders of this variety at Kew revealed that most of the specimens could be referred to *Poa sterilis* M.B., some to *P. araratica* Trautv. and that about half a dozen other species absorbed the remainder.

14. **Poa polycolea** Stapf, in Hook. f., Flor. Brit. Ind. 7: 342 (1896).

A perennial, stoloniferous grass with slender, wiry stems. *Culms* erect, terete, smooth, from a somewhat geniculate or creeping base, up to 30 cm. tall, clothed at the base with many characteristic, scarious, shining, pale straw-coloured sheaths which have slipped from the culm and are persistent; nodes smooth and glabrous. *Leaf-blades* narrowly linear or subsetaceous, the lower up to 8 cm. long, smooth and glabrous on the upper surface, minutely scabrous below and on the margins, linear-acuminate from an abruptly rounded base. *Sheaths*, apart from the basal, tightly fitting, smooth and glabrous, deeply striate, upper sheath much longer than its leaf-blade. Ligules very short, up to 1 mm. long or a little longer.

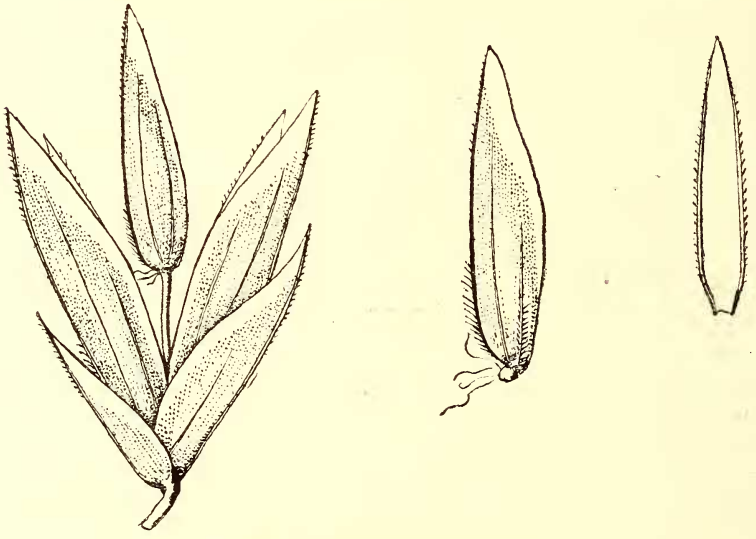


Fig. 11. *Poa polycolea* Stapf, × 10

Inflorescence an effuse panicle, sometimes more or less contracted, seated on a long, exserted peduncle, 5–10 cm. long, nodding or erect; branches whorled, the lower in groups of 2–5, flexuous, slender, smooth, usually carrying spikelets in the upper half only, as a rule only branched to the first degree, and then more often giving rise to a whorl (up to 3) scabrid branchlets which are ultimately spiculate. *Spikelets* seated on short (up to 5 mm. long) scabrid pedicels, 1–3–4-flowered, pale and somewhat silvery in appearance, often suffused with purple, up to 7 mm. long, elliptic-acute before